Chapter 127: Trauma

Lauren D. Holinger, Gabriel F. Tucker

Caustic Ingestion

A variety of corrosive substances continues to find its way into the hands and mouths of children. Often this is the result of parental negligence, ignorance, or even child abuse. As patient age increases, the possibility of suicidal intent must also be considered. Family stress, especially marital conflict, mental and physical illness. and loss of a family member, are associated with caustic ingestions (Friedman, 1987).

It has been over 50 years since Chevalier Jackson personally persuaded Congress to pass its first piece of consumer protection legislation, the Caustic Substances Labeling Act. In spite of this and the more recent Poison Prevention Packaging Act, which mandated child-resistant containers and warning labels, and product liability lawsuits against manufacturers, injury from caustic substances still occurs. In the past, lye and Drano were the most common agents ingested, but the heavy, liquid drain cleaners were the most dangerous, since they burned both the esophagus and stomach. Today such caustics as battery (sulfuric) acid and jeweler's (muriatic) acid are common, as are denture cleansers and toilet bowl cleansers. In modern households alkalines such as sodium hydroxide and potassium hydroxide are found in drain cleaners. Oven cleaning pastes, detergents (both dishwashing and laundry), bleaches, and other household cleaners are also potential hazards. Even children who live on dairy farms are still at risk because of their potential exposure to highly caustic dairy pipeline cleaners. Ingestion of disc batteries (in watches, calculators, etc) with esophageal lodgement can produce life threatening emergencies and long-term esophageal strictures, due to acid leakage. Esophageal lodgement of a disc battery is a true emergency. These children are to be taken to the operating room immediately for endoscopic removal of the battery. Maves (1984) has documented experimentally that perforation can occur within hours of esophageal lodgement.

In addition to such accidental ingestion, some suicide attempts involve the ingestion of caustics, and child abuse often involves injury from acid, boiling water, or hot grease.

Anatomy

When considering caustic trauma to the esophagus one cannot ignore the oral and pharyngolaryngeal structures the caustic agents must traverse en route to the esophagus. The presence or absence of oropharyngeal burns bears no correlation with the presence or absence of esophageal damage.

The child who dabbles in crystalline Drano may severely burn his lips, tongue, and floor of the mouth and spit out the offensive material without swallowing any of it.

Heavy liquids such as Liquid-Plummer and Plunge, if swallowed "chug-a-lug" with suicidal determination, are thought to burh the stomach first and affect the esophagus primarily on regurgitation.

Laryngeal involvement is common in more severe injuries. Here the injury follows the path of the swallowed bolus, involving first the epiglottis and then the piriform sinuses; as such the supraglottic injury can extent to involve the aryepiglottic folds, thus producing a chemical or thermal obstructive supraglottitis. Aspiration of the substance through the larynx to the tracheobronchial tree is rare and indicates that some unnatural means must have been used to result in deep aspiration.

Pathophysiology

First-degree hyperemia is common when weak substances such as Clorox and Lysol have been ingested. These burns can also be caused by a number of detergent preparations.

Second-degree burns imply ulceration, usually at the sites where the bolus slows down in its passage. Such foci may vary, however, with the physical nature of the substance. Discrete crystals of a caustic agent may produce a strawberry-like pattern of blisters. Acids are thought to produce a more superficial coagulation necrosis and less through-and-through ulceration than alkalies.

Third-degree burns involve loss of epithelium with deep ulceration, sometimes with evidence of granulation tissue formation (if sufficient time has elapsed before endoscopy). Third-degree burns are more consistently demonstrated on a contrast esophagram. Superficial first- and even second-degree burns may not be evident on an esophagram.

Symptoms

It would be simplistic to suggest that the patient who has no symptoms has no burns. However, the severity of symptoms usually correlates with the degree of burn. Patients with severe laryngopharyngeal burn may be in acute respiratory distress. Patients with overwhelming burns may also be in shock secondary to either gastric or esophageal perforation. Odynophagia (painful swallowing) may be the result of either oral or esophageal burns; however, this may merely be manifested in small children as a fear to swallow or persistent drooling. Dysphagia, mechanical difficulty in swallowing, is more often associated with mechanical obstruction and as such is more often a late symptom rather than an early one.

As the acute reaction subsides, painful swallowing regresses. There may be sufficient healing for a silent interval of 3 to 6 weeks to elapse before the mechanical effects of scar contracture and stricture formation are apparent.

History and physical examination

Any history of a child playing with a container that contained a caustic solution is suspicion enough for study to rule out an esophageal burn. In most cases of actual caustic ingestion, the child will drool and refuse food. He or she may complain of pain in the mouth or during attempts to swallow. If the burn is severe, the child may have a hoarse cry and respiratory distress.

The history should include the type, amount, and if possible the brand name of the material ingested. The container should be brought to the hospital. It is helpful to know what home or other emergency treatment was given.

The child must be restrained for a careful examination of the mouth and pharynx. A good light and suction are necessary. With a severe burn, there may be excessive secretions with obvious edema or even ulceration in the mouth and the surrounding skin. The abdomen is examined for evidence of peritonitis, which follows a severe gastric burn.

If there is no severe oropharyngeal burn, esophagoscopy and gastroscopy are performed with the patient under general anesthesia within 48 hours. The esophagus is examined for its full length or until a full thickness burn is encountered. Initially, the area of the cricopharyngeus and cervical esophagus is examined with a rigid esophagoscope. The flexible fiberoptic instrument is then passed to examine the esophagus and stomach.

A barium esophagogram is of little value during the acute phase, since it will not detect mild injury and will delay esophagoscopy. If an esophagogram is done, the presence of an atonic or dilated esophagus is evidence of a profound injury.

Management

Overwhelming burns that involve the airway require tracheotomy in some instances. Similarly, various third-degree burns may produce a shock syndrome that requires adequate management. Ritter et al (1971) suggest that penetrating gastric burns, associated most commonly with heavy agents such as Liquid-Plumer, may indeed require emergency esophagogastrectomy.

Steroids

The use of steroids in severe burn patients has been condemned by some since they tend to mask abdominal signs or symptoms coincident with perforation of the stomach. However, if gastric perforation is thought to be unlikely, the use of steroids contributes greatly to patient comfort, permits early swallowing (thus avoiding the need for a feeding tube), and, most importantly, lessens cicatrix formation. To be effective in the prevention of cicatrix formawtion, steroids should be administered within the first 24 hours; they will be ineffective if they are administered 96 hours or more after the initial burn. The use of steroids allows treatment to begin while the patient is stabilized and the general situation evaluated.

based on data from their controlled trial, Anderson, Rouse, and Randolph (1990) suggest that steroids are not at all indicated in children with caustic injuries of the esophagus. However, a careful review of their data suggests they did not have an adequate number of cases to show the benefit of steroids. We continue to advocate the use of steroids for prevention of esophageal strictures following caustic ingestion, unless a third degree injury is present.

Endoscopy

Endoscopy is performed as soon as possible to determine the presence of burn. Endoscopic examination can be combined with the initial intubation at the time of anesthetic induction to determine the presence or absence of deep hypopharyngeal burn. Such a burn would contraindicate the passage of an esophagoscope. If a cricopharyngeal burn is found, the procedure is discontinued without laryngeal intubation. If no significant laryngopharyngeal burn is seen at the time the larynx is exposed for intubation, intubation can be accomplished and the esophagus examined under relaxant anesthesia. The esophagus should be examined only to the point at which significant burn is found, since the passage of an instrument into or beyond a burn area may result in a perforation. Conversely, if no burn is found, the examination should be carried all the way to the cardia. If the results of this examination are negative, steroids should be discontinued.

Radiographic examination

Radiographs are most useful in the later stages (at 3 to 6 weeks) when one is attempting to quantitate or even rule out stricture formation. Radiographs are not thought to be useful in any attempt to rule out superficial first- and second-degree processes, although they may confirm the diagnosis of third-degree burn if gross irregularity and ulceration are present. Indeed, if positive findings of deep ulceration are beyond question on radiographic examination, endoscopic examination may be unnecessary. However, a "normal" esophagogram does not rule out the presence of first- or even some second-degree burns.

Esophagoscopy

In these litigious times it is well to remember that the performance of esophagoscopy without a preliminary esophagogram places the physician at risk. The advisability of a preendoscopic esophagogram has been stated repeatedly in the literature for the last half century.

Feeding tubes

Management with steroids makes spontaneous swallowing much more tolerable to the average patient, making feeding tubes unnecessary. Some otolaryngologists-head and neck surgeons argue that a feeding tube places the esophagus at rest while others suggest that the placement of a feeding tube results in esophageal stasis and further irritation.

In cases of severe esophageal injury, Wijburg et al (1985) have advocated the placement of a nasogastric tube to prevent esophageal stricture. The rationale is similar to that of Reyes and Hill (1976). The tube prevents adherence of the anterior esophageal wall to the posterior wall during the healing period until the mucosa has reformed. It does not function as a true stent.

Psychiatric consultation

Psychiatric consultation should not be overlooked in suicidal patients, since they may require protective nursing measures not usually considered in acute medical management.

Friedman (1987) has emphasized that caustic ingestions may be an overlooked form of child abuse. Evaluation by social services is important in preventing repeat injuries to the child and injuries to siblings.

Hypopharyngeal ("Esophageal") Perforation

Perforation of the laryngopharyngeal mucosa proximal to the cricopharyngeus may be caused by the lodgment of a sharp foreign body at this region. This area is also the most frequent site of endoscopic instrument trauma during rigid or flexible esophagoscopy, bronchoscopy, and even endotracheal intubation.

Anatomy

A few features of hypopharyngeal anatomy are worthy of note. First, in the resting patient the postcricoid laryngeal mucosa lies in contact with the posterior hypopharyngeal mucosa. Second, the cricopharyngeal sphincter is not a true sphincter but a muscular sling attached to the lateral aspects of the cricoid cartilage. This pharyngoesophageal segment is normally closed and has only a potential lumen until the larynx is lifted forward and away from the cervical spine. Finally, in patients with Zenker's diverticulum, the cricopharyngeus muscle moves anteriorly with the cricoid, leaving a lumen behind the cricopharyngeus that leads only to the diverticular pouch. The lining of the diverticulum consists of mucosa without muscular reinforcement and is especially susceptible to perforation. A number of precautionary steps will help to minimize the chances of such perforation.

Management

Radiographic examination

Preesophagoscopic radiographs should include a swallowing function or cervical esophagogram that demonstrates the cervical esophagus and cricopharyngeus. The contrast material should be sufficiently thick to distend this region fully. Lateral soft tissue films of the neck are helpful to demonstrate not only soft tissue but also the subglottic airway and cervical spine.

All films should be available in the endoscopic room at the time the procedure is performed. Verbal or written GI series, esophagograms, or barium swallows that do not demonstrate the cervical esophagus are not acceptable substitutes for the films themselves. Complete (high) esophageal obstruction is the only exception under which the surgeon should proceed without the films.

The use of a barium-impregnated cotton bolus can drive a sharp foreign body through the esophageal wall and into the mediastinum.

Mechanical guidance

The use of previously swallowed string as a guide is probably the safest technique, especially if a diverticulum is suspected. At least 5 feet of string should be swallowed - sufficient to permit safe traction on the proximal end without dislodging the string. (Occasionally the bolus of string itself causes gastrointestinal complications.)

Flexible fiberoptic esophagoscopy

The large square end of the fiberesophagoscope makes it difficult to introduce such an instrument blindly because the cervical esophagus is seen only as the instrument is withdrawn. Radiologic examination (esophagogram, lateral neck, barium swallow) is especially necessary to rule out cervical esophageal and hypopharyngeal pathologic conditions before flexible esophagoscopu examination. If the radiographs are not absolutely negative, direct inspection should be undertaken before the passage of a flexible instrument.

Esophagoscopy

In esophagoscopy the anesthesiologist and endoscopist no longer compete for the same working space. Endotracheal anesthesia can usually be accomplished with ease. An endotracheal tube not only assures the anesthesiologist of a working airway but also prevents the endoscopist from compressing the trachea from behind. The act of intubation itself involves specific hazards and requirements, especially in patients with cervical esophageal conditions. It is often best to apply local anesthesia to the larynx and to intubate the patient with the aid of local anesthetic before proceeding to induction of general anesthesia. Placement of the endotracheal tube must be precise. Many anesthesiologists do not consider entrance of the endotracheal tube into the upper esophagus instead of the larynx as a serious mishap. The danger of serious damage to an esophagus that contains a tumor or a foreign body or to patients with a high-level stenosis is quite apparent if the endotracheal tube is inadvertently placed through the cricopharyngeus muscle.

Exerting pressure on the anterior wall of the larynx to bring it into the view of the anesthesiologist's laryngoscope must be done with caution in the presence of a cervical esophageal tumor mass or foreign body. Such pressure may bring the posterior tracheal wall forward with subsequent trauma to the wall by the endotracheal tube.

Positive pressure respiration-inspiration is accomplished by increasing the endothoracic and pleural pressures with a consequent squeeze on the esophagus, which is opened through the endoscope to the atmposphere. This may be especially troublesome when one is dealing with tightly impacted foreign bodies or those that are irregular and whose points are embedded in the esophageal wall. In such cases the anesthesiologist must make a more physiologic form of inspiration possible so that the esophagus will be opened by negative extraesophageal pressure.

Retropharyngeal abscess may be caused by a perforating pharyngoesophageal foreign body; an aluminum tear tab or a sharp fragment of hard plastic may be sufficiently radiolucent to obscure the diagnosis of the underlying foreign body. In some cases endoscopic removal of the foreign body has provided sufficient drainage to allow the abscess to be

managed medically. In other cases external drainage of the retropharyngeal abscess has seemed advisable.

Thoracic Esophageal Perforation

Dilatation of strictures associated with gastroesophageal reflux or hiatal hernia commonly occurs near the diaphragm as do attempts to dilate obstructions caused by gastric carcinoma coming upward in the vicinity of the cardia. The anatomic point most frequently missed is the anterior angulation of the esophagus as it approaches the diaphragm. Such perforations are therefore thought to be posterior as a result of the operator's inability to stay with the lumen as it angles forward. External trauma to the thoracic esophagus resulting either from surgery within the chest or penetrating wounds of the chest can occur at any level.

Here suspicion of thoracic esophageal perforation is an indication for early thoracic surgical consultation. In cases where the periesophageal tissues are scarred by periesophagitis or long-standing mediastinitis, conservative management is likely to be possible. However, when the periesophageal tissues are essentially normal before the insult, the possibility of severe infection dissecting through the mediastinum requires early surgical intervention.

Perforation Secondary to Dilatation

Chevalier Jackson (1922) pointed out that the esophagus distends above a chronic obstruction. If the endoscopist conceives the stenosis as a gradual fusiform narrowing and proceeds to dilate blindly the redundant distended segment is usually perforated (Fig. 127-1).

Retrograde dilatation uses the forces of traction rather than pulsion. Even this may result in splitting if vigorous dilatation is attempted. In practice it is probably safest to use no more than two or three consecutive working dilators.

Steroid therapy poses a dilemma that has not yet been fully resolved. If administered sufficiently early, such therapy prevents the occurrence of the scar, which in truth probably protects the patient from the dilator. It is suggested that a patient's stricture not be dilated while the patient is receiving steroids. Those strictures that have occurred in spite of steroid therapy should be approached with extreme care.

Esophageal Stenosis

Esophageal stenosis results from either contraction of the cricopharyngeal or cardiac sphincter or stricture of the esophagus. Stricture is defined as a morbid narrowing of a canal, duct, or passage, especially of the urethra, esophagus, or intestine.

Contractures

Both the cricopharyngeal sphincter and the cardiac sphincter are normally contracted and relaxed only as part of the swallowing act. In addition to the relaxation of the cricopharyngeal sphincter, the larynx must be lifted away from the cervical spine by the suprahyoid musculature. Disease affecting the cranial nerves of the brain stem or conditions such as hydrocephalus, Arnold-Chiari malformation, and vascular or metastatic lesions in the

brain stem may impair the initiation of swallowing. Otolaryngologists should also be aware that extensive suprahyoid surgery may result in aspiration, which seems to be the result of esophageal obstruction. Zenker's diverticulum can also be considered secondary to the failure of the cricopharyngeal muscle to relax. In this regard cricopharyngeal myotomy has been suggested by many as a logical part of diverticulectomy.

Achalasia, or cardiospasm, is essentially the failure of the lower esophageal sphincter to relax as part of the swallowing act. This is part of a larger complex in which there is also an intrinsic esophageal neurologic deficit with poor or absent esophageal peristalsis. The end result is massive dilatation of the thoracic esophagus, which is often accompanied by a history of regurgitation of undigested food and even aspiration and chronic pulmonary disease. Myotomy of the cardiac sphincter (Heller procedure) involves incision of the cardiac sphincter to, but not through, the esophageal mucosa. Endoscopically brisk dilatation of the cardiac sphincter with either pneumostatic or hydrostatic dilators has often provided good symptomatic relief. Incompetence of the cardiac sphincter following a Heller operation presents a dilemma wherein acid refluxes through the incompetent sphincter causing a peptic esophagitis and stenosis of the lower esophagus. Such stenosis, however, is much more dangerous to dilate since there is no longer an intact periesophageal cardiac sphincter at this point.

Strictures (Fig. 127-2)

Congenital atresia of the esophagus and its association with tracheoesophageal fistula are well known. Less well known is the congenital stricture of the esophagus that often curves at the junction of the upper and middle thirds of the esophagus. Its presentation is not nearly as dramatic as true atresia since the infant usually handles liquids well. Obstruction occurs only with the introduction of solid food into the diet.

Congenital short esophagus is the term applied to the endoscopic finding of gastric mucosa above the cardiac sphincter. Thoracic surgeon approaching the esophagus thoracically have doubted the existence of such an entity, stating that all such cases are in reality hiatal hernias. Further distinction here must be made between a short esophagus, hiatal hernia, and a Barrett esophagus, which is thought to be caused by reflux esophagitis in which the lower esophagus is lined by columnar epithelium with stricture formation at the squamocolumnar junction.

Regurgitation reflux may also be associated with esophageal stricture. Chronic vomiting, especially self-induced, may eventually cause strictures. The nasogastric tubes have been known to permit reflux through the cardia and set up an esophagitis. The level of the stenosis produced depends on the height of the reflux. Of special interest to the otolaryngologist is the phenomenon wherein patients who are on nasogastric feeding after laryngectomy complain of chest pain. At first the pain seems to be anginal in origin, but it really results from acid reflux in the lower esophagus.

Trauma, inflammation and infection, sites of anastomosis after tumor resection, and congenital atresa may cause stenosis. Poor passage of the peristaltic wave through the site of an anastomosis may lead to lodgment of a foreign body without actual stricture formation. Cervical esophageal strictures are classically part of the Plummer-Vinson syndrome of

atrophic esophagitis.

A foreign body may lodge in the midesophagus subsequent to radiation therapy of pulmonary neoplasms. The bridge in this case is secondary esophagitis and stenosis. Esophageal strictures also occur in such lesions as epidermolysis bullosa, pemphigoid, typhoid, and even measles. In scleroderma the walls of the esophagus become thick, and although the endoscopist may not find a specific stricture, the patient often is helped symptomatically by the passage of an esophageal dilator.

Evaluation

Radiography, combining as it does static pictures of esophageal anatomy with fluoroscopic demonstration of the dynamics of swallowing, is the first method of evaluation. The following points should be borne in mind. First, if very thin barium is given, it may flow so readily down the esophagus that a partial obstruction is not demonstrated. Therefore thick contrast material should be used when one is attempting to demonstrate partial obstruction. Second, material that squirts through an esophageal stricture may make the stricture appear longer than it actually is. Third, a variety of motor disturbances of the esophagus may at first glance appear to be stricturs; however, with good fluoroscopy these can often be differentiated.

Esophagoscopy may well be necessary to differentiate the failure of the cricopharyngeus or the cardiac sphincter to relax from a true stenosis. Also important in the differential diagnosis of lower esophageal obstruction is carcinoma of the cardia and stomach encroaching on the lower esophagus.

Motility studies have been helpful in differentiating anatomic from physiologic obstruction.

Methods of Dilatation

As mentioned previously, pushing through an obstruction to achieve dilatation should be approached with great caution. The surgeon should be sure that the dilator is indeed following the true lumen of the esophagus and not perforating the esophageal wall. A number of techniques have been devised, including the use of a previously swallowed string or feeding tube. The endoscope itself may be used as a dilator if one can safely see the lumen head and use the bevel tip of the esophagoscope as a dilator. Soft, mercury-filled bougies have been devised that are passed by their own weight and are not pushed ahead. The blunt-tip Hearst mercury-filled bougie and the more tapered Maloney bougie are very effective if one resists the temptation to push. Vapor dilators made of stiff substances such as Teflon or whalebone can be extremely dangerous if pushed blindly down the esophagus.

The Tucker dilator (Fig. 127-3), which was first introduced 50 years ago, has the advantage of being pulled retrograde through the esophageal stricture. Similarly, a dilator may be pulled prograde to the stomach and then brought back without causing dilatation and leakage at the gastrostomy site. Such dilatation is done by traction rather than pulsion.