

A Review of Esophageal Disc Battery Ingestions and a Protocol for Management

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Objective: To review our experience with esophageal disc battery requiring endoscopic retrieval and describe a protocol for management.

Design: Retrospective medical chart review.

Patients: Pediatric patients who underwent endoscopic retrieval of an esophageal disc battery over a 10-year period.

Results: Ten pediatric patients had ingested an esophageal disc battery that required endoscopic removal. Three patients had minimal esophageal damage; the other 7 sustained severe and extensive esophageal damage involving the muscularis (n=5) or developed a perforation

(n=2). One of these patients had an extensive injury that extended into the trachea resulting in a tracheoesophageal fistula. Two case reports are presented, outlining the management approach to esophageal perforations from esophageal battery ingestion.

Conclusions: Severe injury can occur rapidly following disc battery ingestion. A high index of suspicion for an esophageal disc battery is necessary to expeditiously diagnose this condition. Emergency endoscopic removal is necessary. We outline a protocol for the management of this hazardous problem.

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A DISC BATTERY IS AN INCREASINGLY common foreign body (FB) ingested by children. In 1998, the American Association of Poison Control Centers¹ reported a total of 2063 disc battery ingestions. This number increased 80% over the next 8 years.¹ There is significant morbidity when the battery is lodged in the esophagus. The physiologic damage is caused by leaking alkaline contents causing a liquefactive necrosis, electrical discharge leading to low-voltage burns, and pressure necrosis.²

To our knowledge, the first case of esophageal damage caused by an ingested disc battery was reported in 1977, when a camera battery eroded through the inferior thyroid vessels causing death.³ Another case resulted in a tracheoesophageal fistula (TEF), subsequent stricture formation requiring dilatations, and ultimately partial esophagectomy with primary anastomosis.⁴ Additional cases have reported the need for serial dilatations, steroid treatment, and reconstructive procedures.^{2,5-8}

Despite the recognized sequelae from this condition, there has been little discussion with regard to optimal manage-

ment. The purpose of this study was to review our own experience of this hazardous problem and to formulate a protocol to assist in managing esophageal disc battery ingestion.

METHODS

The institutional review boards of the University of Utah and Primary Children's Medical Center (PCMC) approved this study. University Medical Billing Department provided a list of all patients who underwent endoscopic retrieval of an FB by the pediatric otolaryngology service between January 1, 1998, and April 2008. Each operative report was reviewed to determine whether a disc battery was present. For each disc battery case, further medical chart review was conducted to gather data on patient sex, age, presenting symptoms, preoperative radiography findings, intraoperative findings, treatment provided, outcome, and follow-up.

RESULTS

Ten cases involving an esophageal disc battery requiring endoscopic retrieval were identified over a 10-year period. Patient data are outlined in the **Table**. There was

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Table. Summary of Patient Data

| Patient No./ Sex/Age, y | Battery Type or Size | Presenting Symptoms, Duration of Ingestion | Intraoperative Findings | Treatment | Length of Stay, d | Outcome |
|-------------------------|----------------------|---|---|---|-------------------|---|
| 1/F/0.79 | 2.1 cm | Cough, dysphagia, stridor, 30 d | Erosion into esophageal muscularis with contained perforation | NGT, TPN, and IV Atbx \times 1 wk | 9 | Esophageal stricture with single dilatation at 3½ mo |
| 2/M/1.08 | Lithium | Lethargy, dysphagia, cough, rhinorrhea, stridor, 7 d | Perforation and tracheal injury | Tracheal and esophageal reconstruction | 30 | Intermittent "croup" 3½ y after injury |
| 3/M/1.25 | Quarter sized | Lethargy, drooling, dysphagia, emesis, 5.5 h | No esophageal injury | Observation, clear liquid diet started the following day | 1 | No sequelae |
| 4/M/0.83 | Quarter sized | Dysphagia, fussiness, gagging, emesis, 3.5 h | Superficial esophageal injury | NGT \times 7 d | 5 | Transient esophageal stenosis, patient stable after 5 y |
| 5/M/9.50 | 2.3 cm | Chest pain, emesis, 3 h | Erosion into esophageal muscularis | NGT feedings \times 4 wk, Atbx | 1 | Normal esophagram at 2 mo |
| 6/M/1.75 | NR | Asymptomatic, 10 h | Erosion into esophageal muscularis | Strict NPO, TPN, and IV Atbx \times 7 d, full liquid diet \times 2 wk | 8 | Normal esophagram at 7 d |
| 7/M/4.00 | NR | Dysphagia, drooling, 3 h | Erosion into esophageal muscularis | NGT feedings \times 2 wk, Atbx | 4 | Normal esophagram at 2 mo |
| 8/F/3.00 | NR | Sore throat, drooling, 6 h | Erosion into esophageal muscularis | NGT feedings \times 2½ wk, Atbx | 4 | Normal esophagram at 2 mo |
| 9/F/5.00 | NR | Sore throat, tachycardia, fever, abdominal pain, 12 h | Erosion into esophageal muscularis | NGT feedings \times 6 wk, Atbx | 4 | Normal esophagram at 6 wk |
| 10/F/4.00 | NR | Chest and abdominal pain, 4.5 h | Superficial esophageal injury | Observation, clear liquid diet started the following day | 3 | No sequelae |

Abbreviations: Atbx, antibiotics; IV, intravenous; NGT, nasogastric tube; NPO, nothing by mouth; NR, not reported; TPN, total parenteral nutrition.

a 1.5:1 male to female ratio. The mean (SD) age was 3.2 (2.7) years (age range, 9.5 months to 9.5 years). A plain chest radiograph was performed for every patient; 1 patient also underwent a chest computed tomographic (CT) scan.

Five patients had an observed ingestion or were found coughing. Two patients complained of a sore throat and self-reported FB ingestion. Three patients were diagnosed incidentally via chest radiograph (2 exhibited persistent upper respiratory tract symptoms, and 1 had the FB discovered during a workup for chest and back pain after falling off her bike). The mean (SD) length of stay for each child was 6.9 (8.5) days, with a range of 1 to 30 days. Six patients were seen within 6 hours of ingestion, 1 after 10 hours, and 1 after 12 hours. Two patients had a substantial delay in discovery of the FB: 7 days and 30 days after ingestion.

Eight of the 10 patients underwent direct laryngoscopy, bronchoscopy, and esophagoscopy with FB retrieval. The other 2 patients underwent rigid esophagoscopy with FB removal. A spectrum of esophageal injury ranged from normal examination to TEF. Three patients had minimal esophageal damage: 1 with no injury and 2 with superficial mucosal injury. The other 7 patients had more severe and extensive esophageal damage involving the muscularis (n=5) or resulting in perforation (n=2). One of these patients had an extensive injury that extended into the trachea resulting in a TEF. Both patients with an esophageal perforation had a substantial delay in their diagnosis, one at 7 days and the other at 30 days after ingestion.

CASE 1

A 9½-month-old girl was seen in an urgent care facility with a 3-day history of fever, otalgia, and anorexia. She also had 1 episode of emesis several days prior to her presentation. She was seen multiple times over a 4-week period with a persistent cough. A chest radiograph was obtained, which showed an FB suggestive of coin ingestion. The patient was referred to PCMC.

On admission, the patient had slightly high-pitched stridor on auscultation, absent retractions or drooling, and normal oximetry findings. Chest radiography showed a 21-mm upper-thoracic esophageal FB suggestive of a battery, with secondary tracheal narrowing. Because of the prolonged duration of FB retention, a CT scan was ordered to characterize the tracheal injury before endoscopy. The CT scan showed the FB in the upper thoracic esophagus, marked anterior-to-posterior narrowing of the trachea, retropharyngeal and superior mediastinal soft-tissue thickening, and no abscess. The patient underwent emergency direct laryngoscopy, bronchoscopy, and esophagoscopy for removal of the FB.

Intraoperatively, a disc battery was detected endoscopically in the cervical esophagus and removed. The esophageal mucosa was ulcerated, but we saw no evidence of a perforation. The rigid endoscope was not advanced beyond the ulceration, to avoid potential iatrogenic perforation. Rigid bronchoscopy revealed a near-complete compression of the trachea posteriorly without evidence of perforation. The child then underwent an esophagram. Isovue-370 contrast material (Bracco

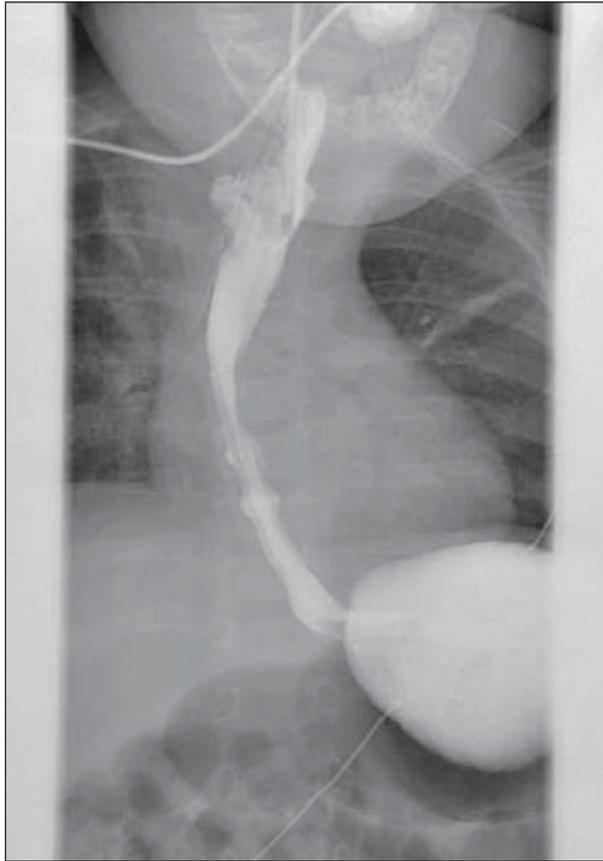


Figure 1. Esophagram illustrates a contained posterior perforation.

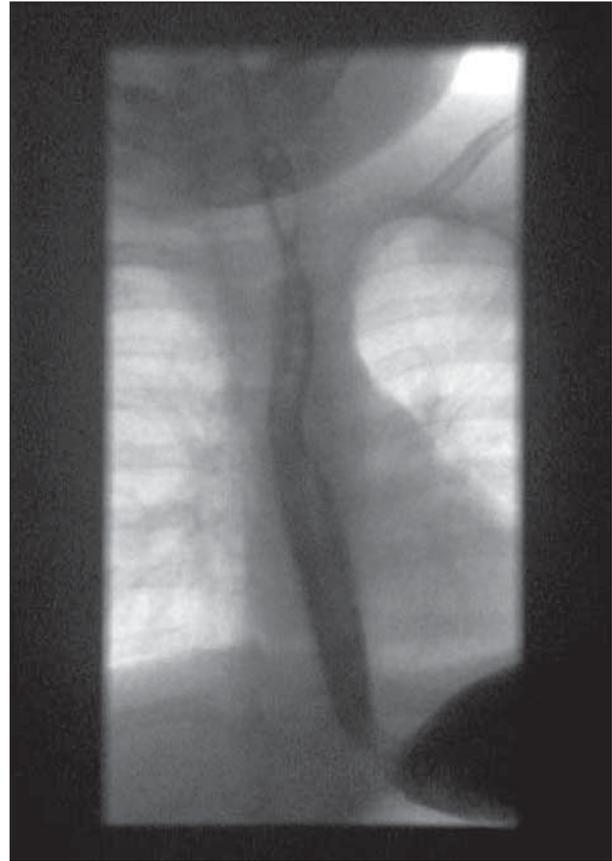


Figure 2. Esophagram performed 6 weeks after initial endoscopy illustrates a focal stricture.

Diagnostics Inc, Princeton, New Jersey) was injected into the upper thoracic esophagus and revealed a small contained posterior esophageal perforation (**Figure 1**). A nasogastric (NG) tube was inserted under fluoroscopic guidance to stent the area of esophageal injury and provide future access for feedings.

The following day, a peripherally inserted central catheter (PICC line) was placed; total parenteral nutrition and treatment with broad spectrum antibiotics were initiated. A strict nothing-by-mouth diet with the NG tube to low intermittent wall suction was continued for 7 days. On hospital day 8, a repeated esophagram showed a healed perforation with no evidence of stricture or extravasation. The NG tube was removed, and the patient's diet was advanced from clear liquids only to full liquids over the next day. The full liquid diet was continued for 1 week after discharge.

At the patient's 6-week postoperative visit, an esophagram showed a persistent focal area of 50% narrowing, which was treated by balloon dilatation (**Figure 2**). At 1-year follow-up, the patient was well and showed no symptoms of dysphagia.

CASE 2

A 13-month-old boy recently diagnosed as having otitis media had persistent lethargy, progressive dysphagia, and mild respiratory distress for 7 days. He was seen at an outside facility for evaluation, and a chest radiograph re-

vealed an esophageal FB at the thoracic inlet. He was immediately transferred to our facility for evaluation.

When we first saw him, the patient was in no acute respiratory distress. The mother was unaware of any history suggesting FB ingestion. A review of the outside chest radiograph indicated a possible esophageal disc battery, and the patient underwent emergency endoscopic examination and removal of the FB. Direct laryngoscopy, esophagoscopy, and bronchoscopy revealed a complete perforation of the anterior esophagus and the posterior trachea just left of midline (**Figure 3**). A small feeding tube was placed under fluoroscopic guidance to stent the defect. Postoperatively, the patient was transported to the pediatric intensive care unit in stable condition, where a PICC line was placed to administer intravenous antibiotic therapy.

On postoperative day 3, a gastrojejunostomy (GJ) tube was placed, and the tracheoesophageal damage was reassessed. The tracheal defect was slightly longer than noted initially, and there was granulation tissue and fibrinous material within the esophagus. In the following days, the TEF site was reassessed 3 more times.

On hospital day 19 the patient underwent definitive surgical repair. A partial median sternotomy was performed to provide surgical exposure of the tracheal and esophageal injury. Tracheal end-to-end reanastomosis, primary repair of esophageal perforation, and a local strap muscle interposition between the 2 structures were performed (**Figure 4**).



Figure 3. Bronchoscopy reveals large tracheal defect just left of midline at 12 to 13 cm from the teeth (arrow).

Eight days later, an esophagram showed mild narrowing at the esophageal anastomotic site without any evidence of leak. With the GJ tube still in place for feedings, the patient was discharged to home on hospital day 30. The GJ feedings were stopped about 4 weeks later.

Over the next 3 months, the patient was admitted to the hospital 7 times for complaints of stridor, respiratory distress, and difficulty sleeping. The tracheal anastomosis and esophagus were assessed on each admission. Granulation tissue was removed each time, with periodic application of mitomycin C. On the final readmission for progressive dysphagia and intolerance to solids, a dime was found in the cervical esophagus without evidence of esophageal stenosis.

More than 3½ years after his esophageal and tracheal reconstruction, the child continued to develop intermittent croup-like symptoms. All episodes were managed medically with racemic epinephrine or systemic steroids. A follow-up bronchoscopy revealed a patent airway free of significant stenosis, while esophagoscopy showed reflux esophagitis changes at the lower esophageal sphincter, for which he was receiving medical therapy at last follow-up.

COMMENT

Disc battery ingestion is becoming a frequent problem, since more battery-powered electronic devices are being used by children. Many of these FBs will lodge in the esophagus and may cause extensive damage or even perforation. To our knowledge, the present report represents one of the largest series of patients with esophageal disc batteries requiring endoscopic removal.

In a study performed in Taiwan,⁹ the authors analyzed data that were reported to a hospital poison control center over a 9.5-year period of time. They evaluated a total of 25 episodes of disc battery ingestion. Only 1 of these patients had the battery lodged in the esopha-

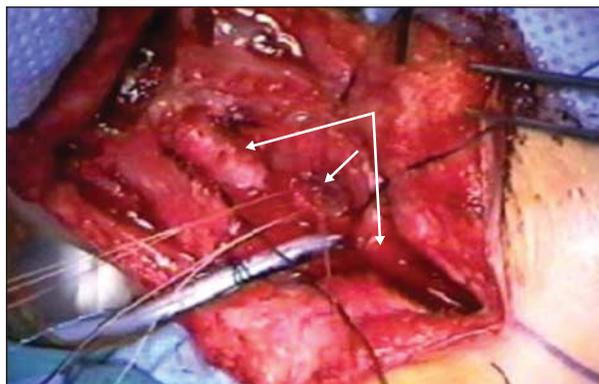


Figure 4. Tracheal end-to-end reanastomosis and primary repair with local strap muscle closure. Short arrow shows esophageal primary anastomosis site. The long arrows show the proximal and distal trachea prior to repair.

gus and required endoscopic retrieval. This patient subsequently developed a TEF, which closed spontaneously after 8 months of conservative therapy. In a later study,¹⁰ again performed in Taiwan, a retrospective analysis over a period of almost 6 years showed a total of 12 disc battery ingestions. In only 4 of these cases were the FBs lodged in the esophagus causing erosive lesions on endoscopic removal. One of these 4 patients developed a TEF, and another died of tension pneumothorax and pneumoperitoneum as complications of esophageal perforation.

In several reports of missed FB diagnoses, questionable upper respiratory infections were treated for 2, 10, and 12 days, and questionable otitis media was treated for 10 days prior to correct diagnosis.^{5,7,8,11} In 3 of these 4 cases, a TEF was identified that healed spontaneously,^{5,7,11} while the fourth patient developed severe esophageal stenosis requiring recurrent dilatations for more than 2 years.⁸ The 2 patients in our study with a substantial delay in presentation reported a history of respiratory complaints, fever, dysphagia, odynophagia, lethargy, and cough for 7 and 30 days.

Animal studies have demonstrated that severe damage can occur quickly after a disc battery ingestion.¹² A study by Yoshikawa et al¹³ in adult rabbits indicated that the severity of esophageal injury is associated with the position of the alkaline side of the battery against the esophagus and the duration of its presence within the esophagus. In a canine study,¹⁴ substantial esophageal mucosal necrosis was detected within 1 hour of ingestion. Ulceration was found after 2 hours of ingestion. A feline study demonstrated similar endoscopic findings after ingestion.⁴ In addition, perforation was detected 8 to 12 hours after battery ingestion.⁴

Our study confirms that esophageal injury can progress very quickly in children following ingestion of a disc battery. Two patients in our series were seen within 3 hours of ingestion and sustained severe erosion into the muscularis layer resulting in transmural necrosis. One patient who was seen within 4 hours of ingestion developed long-term sequelae from esophageal stenosis.

It is surprising, given the animal studies and clinical reports demonstrating life-threatening complications with delayed diagnosis, that some physicians recommend ob-

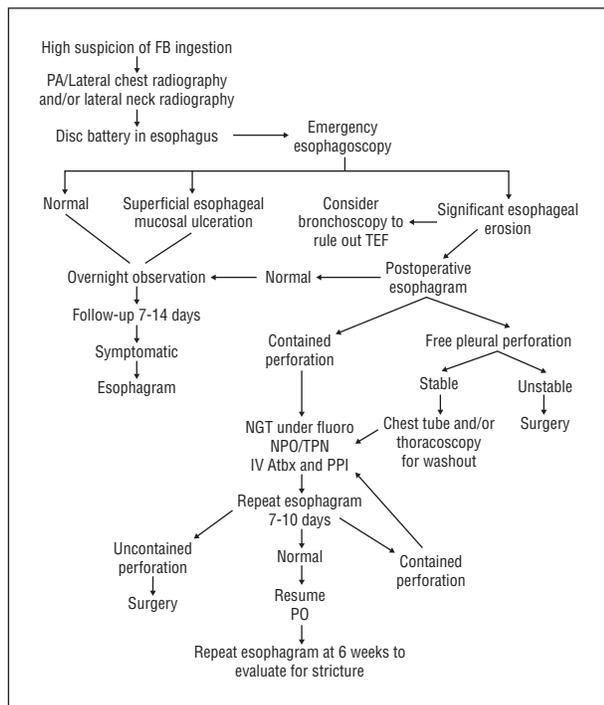


Figure 5. A recommended protocol for the management of an esophageal disc battery. Atbx indicates antibiotics; FB, foreign body; fluoro, fluoroscopic guidance; IV, intravenous; NGT, nasogastric tube; NPO, nothing by mouth; PA, posterior to anterior; PO, orally; PPI, proton pump inhibitor; TEF, tracheoesophageal fistula; TPN, total parenteral nutrition.

servation. In a study evaluating physician attitudes and approaches to management of battery ingestion,¹⁵ a total of 312 questionnaires were completed by members of the endoscopic and pediatric sections of the British Society of Gastroenterology: 6.4% of the respondents used medical management; 36.2% were not concerned at all and gave no therapy; 9% did not know how to manage the problem; and only 48.4% removed the ingested batteries under certain circumstances (78% if in the esophagus, 72% if in the stomach, and 48% if in the duodenum) if the exposure was greater than 24 hours. Twenty-two percent would not remove them even if they were lodged in the esophagus!

In contrast to these findings, other authors have emphasized the need for emergency removal of disc batteries.^{2,4,8,11,16} Grisel et al^{6(p703)} have asserted that “timely removal is of utmost importance in cases where esophageal mucosa is exposed to increased electrical potential (eg, fully charged batteries, lithium batteries).” Esophagoscopy and bronchoscopy are the best techniques for evaluating the tracheoesophageal wall for perforation.¹⁷ In our study, 2 patients did not undergo bronchoscopic evaluation. One of these patients had only superficial mucosal involvement, while the other had extensive charring through the mucosa. It is unclear why bronchoscopy was not performed in either case. Imamoğlu et al¹⁸ advocate meticulous endoscopic examination of both the esophagus and the trachea after battery retrieval for early diagnosis of any serious complications.

Recommendations for management of esophageal perforation after removal of an FB have ranged from early repair to conservative observation. Several case reports

have described spontaneous closure of the tracheo-esophageal fistula as early as 4 to 6 weeks after FB removal,^{5,7,11,19} while another case reported delaying closure for as long as 8 months.⁹ Even after spontaneous closure, subsequent complications, fistulas, and severe stenoses have developed that required surgical repair.^{4,6} Two studies have reported conservative therapy that failed after 2 and 5 weeks, with persistent fistulas that required surgery.^{20,21} Other cases were surgically treated immediately to repair the TEF either in a primary or a multistaged procedure.^{14,16} The patient from our study who developed a TEF showed evidence of failed conservative therapy after nearly 3 weeks.

A recommended protocol for managing patients with suspected disc battery ingestion is shown in **Figure 5**. Emergency esophagoscopy is mandated when a disc battery is identified on chest radiography. When substantial esophageal erosion is detected, bronchoscopy may be performed to evaluate the tracheal wall, and an esophagram will assist in evaluating for a perforation. Management of a contained esophageal perforation requires a multidisciplinary approach involving at least pediatric surgery and otolaryngology. In the presence of a contained perforation, conservative measures such as total parenteral nutrition, NG tube placement under fluoroscopy, anti-reflux medication, and intravenous antibiotics should be considered. Conservative management can be continued if radiographic evaluation suggests that the perforation is getting smaller. If the perforation persists after several weeks or enlarges, surgical treatment should be considered. The advantage of delaying surgery is to increase the chance of spontaneous closure and to reduce inflammation at the injury site.^{18,22} A popular technique for repair that was used in our case is tracheal resection followed by primary anastomosis and closure of the esophagus in 2 layers.²³

In conclusion, severe injury can occur rapidly following disc battery ingestion. A high index of suspicion for a disc battery is necessary to avoid life-threatening sequelae. Emergency endoscopic retrieval is required in these situations. Conservative medical management is an appropriate initial approach even for a TEF in a stable patient. A multidisciplinary approach involving otolaryngology and pediatric surgery can be very helpful, especially when a tracheoesophageal fistula and/or uncontained perforation is identified. Using the protocol as outlined provides a simple approach for a potentially complicated problem.

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