



Disc Battery Ingestion in Pediatric Patients

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As the demand for more sophisticated toys and electronics grow, the use of compact high performance batteries is on the rise. These small batteries, often called disc batteries or button cells, are replacing larger AAA or AA battery sizes in many household items and children's toys.

A disc battery or button cell is a small single cell battery shaped as a squat cylinder. They are typically 5 to 25 mm in diameter and 1 to 6 mm high — like a button on a garment, hence the name.¹ These batteries can be found in items such as small toys, hearing aids, car-key fobs, flameless candles, remotes, bathroom scales, watches, greeting cards, calculators, pens, cameras and many other items. According to the 2013 annual report of the American Association of Poison Control Centers, there were 3,503 reported incidences of disc battery ingestion. Of these, 63% were ingested by children younger than the age of five.² The high percentage is due to a child's natural tendency to put things in their mouth while exploring their surroundings.³

LEARNING OBJECTIVES

- ▲ Recall what percentage of patients will most likely pass the battery through the GI tract
- ▲ List the general symptoms that a child may experience after battery ingestion
- ▲ Review which types of radiographic studies will be performed when battery ingestion is suspected
- ▲ Determine which parts of the body are of most concern when this type of incident occurs
- ▲ Examine the process for removing a disc battery from the esophagus

DISC BATTERY INGESTION

Every suspected case of battery ingestion, even in asymptomatic patients, requires immediate medical attention. While about 80% to 90% of ingested disc batteries in children will likely pass spontaneously through the entire gastrointestinal (GI) tract without incident, batteries retained in the body can have detrimental effects.³ Disc batteries

*Figure 1
Shown are the
size of disc
batteries in
comparison
with coins*



can contain numerous heavy metallic salts such as lithium oxide, mercuric oxide, silver oxide and zinc oxide among others that can cause great damage to tissues.⁴ They also contain concentrated solutions of harmful caustic alkaline fluids such as sodium hydroxide and potassium.⁵ The three areas in the GI tract where batteries can meet resistance and become lodged are the esophagus, the stomach and the intestines, with the esophagus being the most common.⁶

DIAGNOSIS

Quicker interventions occur when button battery ingestion is witnessed in children. However, in as many as 40% of cases, battery ingestion in infants and children is not witnessed.³ Children are usually brought to the health-care facility because they start to experience symptoms. Symptoms can vary depending on the location of the battery, the length of time that has passed since the battery was ingested and where the battery is lodged. Symptoms may include: sudden refusal to eat, drooling, decreased appetite, coughing, choking or gagging with eating or drinking, fussiness, stridor, wheezing, respiratory distress, chest pain, abdominal pain, abdominal distention, fever, vomiting, bloody stool and tachycardia, among others.⁵

When foreign body ingestion is suspected, radiographic studies will need to be performed. Typically, these will be plain radiographs (X-rays). Both anteroposterior (AP) and lateral films will be needed to

localize the foreign body. Lateral films will aid in determining if a foreign body is in the esophagus or the trachea and may detail foreign bodies obscured by the overlying spine.³ Coins and disc batteries can look similar on an X-ray, but there are certain characteristics that set them apart. Figure 2 (on page 212) shows the difference between a coin and disc battery on plain radiographs. Disc batteries can have a char-

acteristic double-density shadow or “halo” on AP X-rays. Laterally, these batteries’ edges are rounded, and they sometimes contain a step off junction at the positive and negative terminal.⁸ These differences can help distinguish them from coins and buttons. Once battery ingestion is diagnosed, the physician must determine whether intervention is needed and what degree of urgency is merited.

THE ESOPHAGUS

While batteries have the potential to cause damage in all areas, damage in the stomach and intestines is less likely. The majority of tissue damage occurs when the battery is lodged in the esophagus.⁹ The reason batteries in the esophagus cause more damage is due to the different physiologic conditions in the esophagus as opposed to the stomach and intestines. When ingested, disc batteries discharge their current across tissue or liquid. When in the stomach and intestines, disc batteries discharge their current through the gastric fluid, generally without damaging the mucosa. In

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the esophagus, however, the battery is wedged into tissue. This causes the batteries to discharge their current through esophageal tissue and potentially cause burns.⁴ Damage due

to alkali leakage is also more common in the esophagus. Once the battery is ingested, it begins to deteriorate causing the battery to leak alkaline fluid. In the stomach, the acidic gastric fluid (which has a high PH level) balances out the leaking alkaline fluid (which has a low pH level). This balance keeps the otherwise harmful alkaline fluid from doing damage to the surrounding tissue. In the esophagus, there is no gastric fluid to balance the pH, and therefore, the caustic alkaline fluid leaks directly onto the tissue of the esophagus, undiluted, which can cause severe injuries to the tissue.⁵

The esophagus has three areas of narrowing where foreign bodies such as disc batteries are most likely to become entrapped: the upper esophageal sphincter, the crossover of the aorta and the lower esophageal sphincter. Disc batteries in children most often become entrapped in the upper esophagus, immediately distal to the upper esophageal sphincter.⁶

REMOVAL FROM THE ESOPHAGUS

If it is known that a child has a battery lodged in the esophagus, he/she is automatically upgraded to a level one trauma. If the battery is not visible, the child will require surgery for foreign body removal. A general surgeon will perform a rigid

esophagoscopy to visualize and retrieve the battery. The child will be placed in the supine position and an anesthesiologist will administer general anesthesia. After the time out is taken, a Benjamin open esophagoscope with an attached light source will be placed into the child's esophagus by the surgeon. If the surgeon is able to visualize the battery, he or she will place a non-optical esophagoscopy forceps down through the esophagoscope and retrieve the battery. If the battery cannot be directly visualized through the open esophagoscope, a 2.9mm 0 degree telescope connected to an optical forceps with teeth will be placed down the esophagoscope and used to visualize and retrieve the battery.⁴

After the battery has been removed, the child will be admitted to the hospital. Commonly, a computerized



This X-ray shows the button battery stuck in four-year-old Beckett Goss' esophagus

Photo courtesy of the Goss family

tomography angiography scan (CTA) will be performed to check the integrity of the blood vessels around the esophagus to ensure that they are not damaged. An esophagram (also called a barium swallow) also may be performed to view and assess the anatomy and function of the pharynx, esophagus and check for any damage or leaks. If there is no suspected damage, the child may be released after one day. If there is suspected damage, however, the child will require a longer hospital stay.

COMPLICATIONS

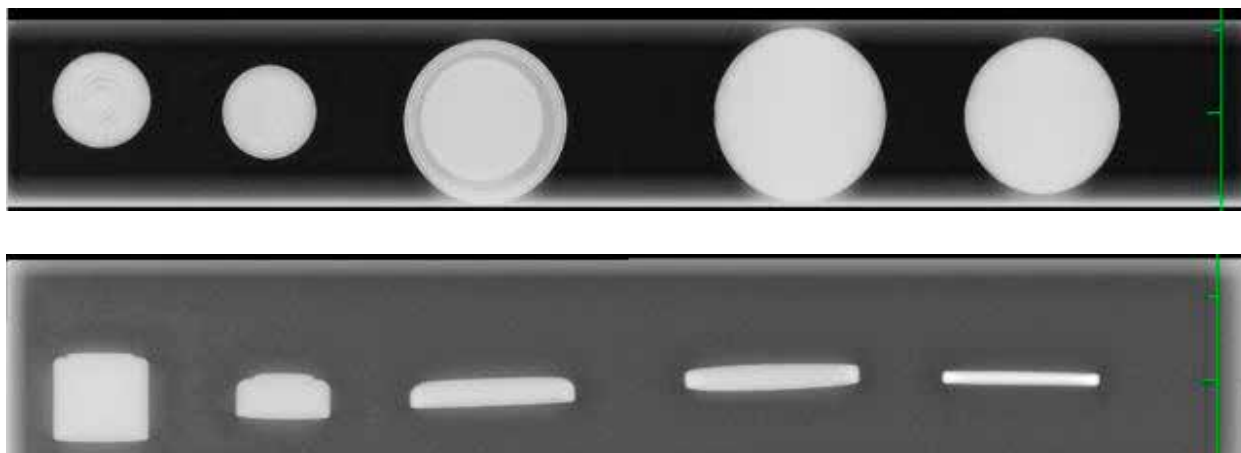
Esophagus

Disc batteries lodged in the esophagus can cause severe tissue damage in as little as two hours.¹⁰ Delayed injury

may also occur in the following days and weeks after the removal of the battery. After battery removal, the damaged tissue will go through multiple stages of necrosis. The first stage is necrosis, which may last as long as a week depending on the severity of the burns. During this time, the child may experience new perforations or fistulas as the esophageal tissue thins before it dies. After necrosis occurs, if additional surgery is not required, the damaged area of the esophagus will begin to heal and scar tissue may form. This scar tissue may cause esophageal strictures and other problems within days to weeks after the battery removal takes place. Children will need to be monitored for these delayed injuries for as

tery through straining all stools, and cathartics may be prescribed to accelerate passage of the battery. If the battery has not been recovered in four to seven days after the ingestion, a repeat radiograph may be performed to assist in discovering why the battery has not passed though.³ If the passage of the battery is delayed, the risk of leakage and the potential for complications must be assessed to determine the need for endoscopic or surgical removal. If the battery is retained in the stomach and unable to pass, an endoscopic procedure to remove it may be necessary. If the battery becomes lodged in the intestine, surgical removal of the battery may be required.

*Figure 2
The front
and side
views
of the
batteries
and coins
following
X-ray*



long as six weeks while the esophagus heals.^{11,12} Injuries that can occur after having a battery lodged in the esophagus include: esophageal perforation, tracheoesophageal fistula, esophageal stricture, vocal cord paralysis, tracheal stenosis, tracheomalacia and exsanguination after fistulization into a major blood vessel such as the aorta.^{6,11} The type and severity of injury will be directly related to the duration and location of the battery, as well as the size and type of the disc battery.⁵ In 2013, of the 3,503 reported cases of disc battery ingestion, 55 patients had moderately negative outcomes, eight cases had major negative outcomes and three cases resulted in death.²

Stomach and Intestines

While most damage occurs in the esophagus, batteries also may become lodged and injure tissue in the stomach or intestines. If a button battery moves through the esophagus into the stomach, there is about a 90% chance it will pass through the rest of the GI tract without incidence within 24 to 72 hours.⁴ The patient may be sent home and instructed to watch for symptoms of toxicity and passage of the bat-

PREVENTION

While being prepared in cases of disc battery ingestion is important, preventing them altogether is the ultimate goal. More than 60% of batteries that are ingested by young children were obtained from products as opposed to loose batteries.¹⁰ Due to this high percentage, and with the number of disc battery ingestion cases on the rise, manufacturers of disc batteries, manufacturers of products that are powered by disc batteries and health and safety government agencies have become more vigilant to find a solution to prevent esophageal injuries. In 2011, battery manufacturers began education programs to raise awareness to the dangers disc batteries and other batteries pose. This educational campaign targeted parents and caregivers through a partnership with Safe Kids Worldwide, The National Capital Poison Center and other health and safety organizations.¹³ The focus of these educational programs is to raise awareness of the potential dangers of disc battery ingestion, and to provide steps for immediate care if a battery is swallowed. Battery manufacturers are partnering in research to investigate what causes the chemical reaction when button batteries are

Beckett's Story

It was September 15, 2013, and our family was enjoying a relaxing Sunday afternoon. We had gathered at my in-laws' home to have dinner and watch the Denver Broncos game. All four of our kids had been playing with their cousins when suddenly Beckett, our 4-year-old son, came upstairs crying. He said his belly was really hurting while he was grabbing his chest. His crying became more intense and when we questioned him further about his pain, he pointed to his chest. We started to wonder if he had swallowed too much dinner as he was notorious for shoveling extra-large bites of food into his mouth. We offered him some water, but drinking it seemed to cause more pain. Then we began to get worried.

We asked him if he had swallowed something. At first he insisted that he had not, but he eventually admitted that he had. He said it was a round magnet he had found on the floor in the playroom downstairs. With this new information and the amount of pain Beckett appeared to be in, we decided to head to urgent care a few miles away.

When we saw the doctor, he asked us if we had seen the object Beckett had swallowed, which we hadn't. Beckett told us it was a magnet and that was all the information we had. He told us Beckett needed an X-ray immediately.

After the X-ray we went back to another examination room and waited. When the doctor came back in, he had a very concerned look on his face. He told us he believed the object Beckett had swallowed was not a magnet but a button battery. He then proceeded to tell us this was a very serious situation and Beckett needed to be transported to the Children's Hospital downtown. He already had called the ambulance. We asked why we should be so worried, to which the doctor answered that button batteries are very dangerous when ingested and can burn a hole through one's esophagus.

Obviously, we were shocked and scared. Beckett continued to cry in pain as we waited for the ambulance. My husband went with him in the ambulance and I ran

home to grab some things. When we got to the ER, it had been about two hours since Beckett had swallowed the battery and he was still in a lot of pain. The ER staff told us he needed to have a scope procedure done so they could try to remove the button battery. Before they took him for the procedure my husband asked if he could give him a blessing. As soon as we said amen, the ER staff started to wheel Beckett back when he really started to complain that he was going to throw up. He did, and there was that button battery lying on his chest that everyone was so worried about. We



Beckett Goss with his father, Brandon, after surgery

Photo courtesy of the Goss family

were so relieved, and naively thought the crisis was over. A doctor soon came in and told us that Beckett still needed to have a scope performed so they could assess the damage to his esophagus.

My husband and I waited impatiently. They finally brought us back to the recovery room to be with Beckett. He was taking a long time to wake up when the GI doctor came to talk to us about his scope. Again, this doctor had a very somber look on her face. She showed us pictures she had taken of Beckett's esophagus. There were two large ulcers that were concerning. She said they still could be burning his esophagus and even burn to the aorta. If this happens, the doctor said, he could bleed out and die.

This was the scariest moment of my life. She told us we

needed to get him transferred up to the Children's Hospital in Denver by ambulance. He would need a contrast MRI to see if the ulcers had burned though. My husband again rode with Beckett in the ambulance with a special crew that could handle the risks that Beckett faced. Once we arrived, they brought Beckett back for another scan.

Again we waited anxiously for the results. This is what my husband posted on Facebook that morning September 16th:

"GI doctors just came in. They are pretty worried because

Over the next few days there were tests, and nurses in and out, doctors to talk to but mostly just waiting around trying not to be worried. Thankfully by Wednesday, Beckett had been doing so well they had moved him out of the PICU and decided to do the MRI a day early.

the battery was charged fully when it entered his body. They are concerned that a fistula will form between the esophagus and aorta which will cause a tear, thus ending his life. She said this has happened to several kids already this year. Very scary. Because of this, we will be here for at least several days, they said, because it takes several days before this fistula begins to form. Poor Beckett. He's getting bored and restless already."

They then told us Beckett needed to have a larger gauge IV put in (he already had two at this point) in case he should suddenly need a blood transfusion.

The next day, September 17, we posted this on Facebook: "The doctors seem to be feeling that his esophagus isn't burning anymore so the only threat now is a fistula growing between his esophagus and aorta. There is nothing they can do proactively to stop this, so we have to just wait it out. They said that if he has a good night (which he did) and passes his tests in the morning that he will get to leave the PICU and will be able to start drinking water (poor guy hasn't eaten or drank anything since 3:30 Sunday). Then we will just sit tight till Thursday when they will put him under and then give him a MRI, which will show if that fis-

tula began to grow. If not, we may go home Thursday night or Friday morning. If there is any sign that it has begun to grow, we may have to go back to PICU.

Thanks again for all the hugs, prayers and kind words. Much love!"

Over the next few days there were tests, and nurses in and out, doctors to talk to but mostly just waiting around trying not to be worried. Thankfully by Wednesday, Beckett had been doing so well they had moved him out of the PICU and decided to do the MRI a day early. The results were good and they told us we would be going home on Thursday. That night he had food for the first time since Sunday. I was so happy to see Beckett feeling happy again.

We were discharged on Thursday with instructions to follow a soft food diet. Beckett would need to take medication three times a day for 35 days to help protect and heal the ulcers in his esophagus. We followed up with the GI doctor a few times in the weeks that followed. Beckett had a follow-up scope of his throat as well, and it showed that his ulcers were healing nicely. We finally felt relief that this ordeal was over.

We later found out how Beckett found the battery in the first place. A few days before we came over, Beckett's grandma was trying to put a button battery into an electronic angle finder. It didn't fit right, however, and it fell out on the floor behind a chair. She was distracted and forgot all about it. When Beckett found it a few days later, he put what he thought was a magnet, in his mouth. Since it was a fully charged battery, it shocked him. This surprised him, which caused him to swallow the battery.

When this all started, I had no idea the severe danger that button batteries pose to children. I know in our case we were extremely blessed that Beckett was able to throw up the battery after two hours. Each second is critical. I have read and heard many other stories about button battery ingestion and know many don't have such positive outcomes. We feel blessed that our story has a happy ending. I often tell others about our experience in hopes that there will be a greater awareness of this huge danger that is often right in our homes. Anytime I see a button battery I still have a sinking feeling in my chest. My hope is that no one ever has to deal with this, but in this increasingly electronic age we live in, they are everywhere.

Tina Goss is a 32-year-old mother of four children. She stays busy running kids to sports and dance classes and works part time as a non-diagnostic ultrasound technician. She loves spending time in the outdoors with her family.

ingested, in hopes that one day decrease the damage if swallowed.¹⁴ There is also a push to establish a maximum size disc battery, which would decrease the likelihood of an ingested battery getting lodged in the esophagus.⁸

Federal regulations in the United States have mandated that safety mechanisms must be placed on any item that contains batteries to prevent the release of batteries from these items by children. These regulations are reviewed by the US Consumer Product Safety Commission regularly by inspection of any item that uses batteries.¹⁵ As a result, product manufacturers are working to develop a better device design that would make it harder for children to open battery compartments. After recommendations were made by the US Consumer Product Safety Commission, battery manufacturers made disc battery packaging using child resistant standards, and standardized warning language on all labels.¹⁶

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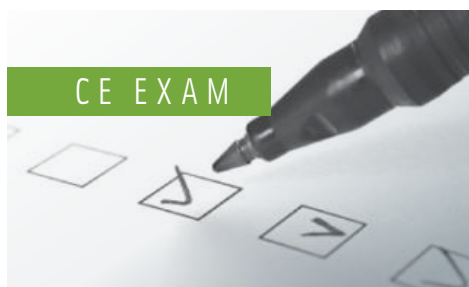


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REFERENCES

1. IEC 60086-3: Primary batteries — Part 3: Watch batteries. International Electrotechnical Commission, Geneva, (1995). (BS EN 60086-3:1996)
2. Mowry JB; Spyker DA; Cantilena Jr LR; McMillan N; Ford M. 2013 Annual Report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 31st Annual Report. *Clinical Toxicology*. 2014; 52, 1032–1283.
3. Ginsberg GG; Pfau PR. Foreign Bodies, Bezoars, and Caustic Ingestions. Feldman M; Friedman LS; Brandt LJ; eds. *Sleisenger & Fordtran's Gastrointestinal and Liver Disease: Pathophysiology, Diagnosis, Management* 9th ed. Philadelphia, PA: Elsevier. Volume 1. 1-1198 2010; 25, 397-405.
4. Jones A. Caustic ingestion and foreign bodies: damage to the upper gastrointestinal tract. Wyllie R; Hyams JS; eds. *Gastrointestinal and Liver Disease: Pathophysiology, Diagnosis, Management* 3rd ed. Philadelphia, PA: Elsevier. 2006; 17, 262-273.
5. Kay M, Wyllie R. Foreign Bodies and Bezoars. Liacouras CA; Piccoli DA; eds. *Pediatric Gastroenterology: The Requisites in Pediatrics*, 1st ed. Philadelphia, PA: Elsevier. 2008; 8, 64-73
6. Munter DW. Gastrointestinal Foreign Bodies. *Medscape reference: Drugs, Diseases, & Procedures*. February 21, 2014. <http://emedicine.medscape.com/article/776566-overview>
7. Hostetler MA. Gastrointestinal disorders. Marx JA; Hockberger RS; Walls, RM; eds. *Marx's Emergency Medicine-Concepts and Clinical Practice*. 8th ed. Philadelphia, PA: Saunders Elsevier; 2013: chap 172.
8. Fuentes S; Cano I; Benavent MI; Gómez A. Severe esophageal injuries caused by accidental button battery ingestion in children. *J Emerg Trauma Shock*. 2014; Oct-Dec; 7(4): 316–321.
9. Sugawa C; Ono H; Taleb M; Lucas CE. Endoscopic management of foreign bodies in the upper gastrointestinal tract: A review. *World J Gastrointest Endosc*. 2014; Oct 16; 6(10): 475-481.
10. Litovitz T; Whitaker N; Clark L. Preventing battery ingestions: an analysis of 8648 cases. *Pediatrics* 2010; 125 (6): 1178-1185. Epub 2010 May 24.
11. Hamilton JM; Schraff SA; Notrica DM. Severe injuries from coin cell battery ingestions: 2 case reports. *J of Pediatr Surg*. 2009 March; 44(3): 644–647.
12. Kramer RE, et al. Management of Ingested Foreign Bodies in Children: A Clinical Report of the NASPGHAN Endoscopy Committee. In *Journal of Pediatric Gastroenterology and Nutrition*. 2015; 60(4): 562-574.
13. Chalmers E. Button Battery Ingestion: An analysis of differences in injury severity outcomes between countries. Kidsafe ACT Incorporated. <http://www.kidsafe.com.au>
14. Energizer Holdings Inc. Coin Lithium Battery Safety. 2000-2015. <http://www.energizer.com>
15. Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report. Injuries from Batteries Among Children Aged <13 Years — United States, 1995–2010. August 31, 2012; 61(34):661-666. <http://www.cdc.gov>
16. US Consumer Product Safety Commission. CPSC Joins International Effort to Prevent Button Battery-Related Injuries and Deaths. June 17, 2014. Release Number: 14-208. <http://www.cpsc.gov>
17. J Giacoppo. Earth 911. March 27, 2009. <http://www.earth911.com>



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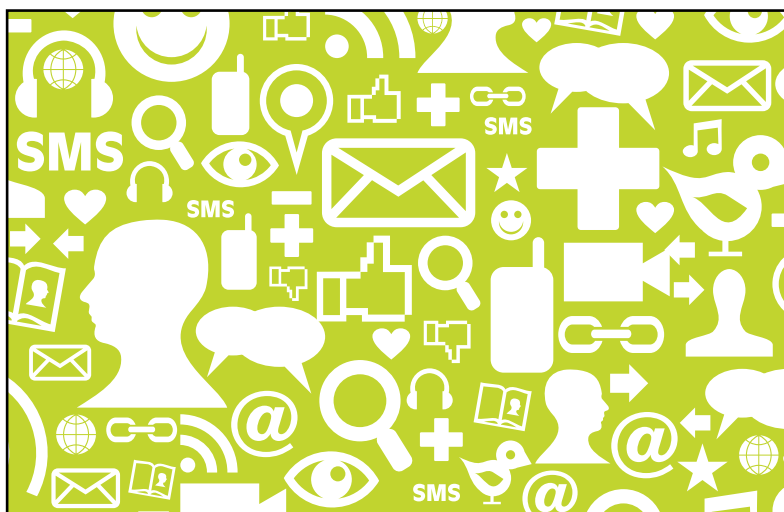
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