

Management of button batteries in the upper gastrointestinal tract of children

A case-series study

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Abstract

Button batteries are the second most frequently-ingested foreign bodies and can lead to serious clinical complications within hours of ingestion. The purpose of this study was to analyze the outcomes of 14 children with button batteries lodged in the upper gastrointestinal tract.

Totally 14 children with button batteries lodged in the upper gastrointestinal tract were included. The diagnosis was made primarily by the history of button battery ingestion, physical examination and chest-abdomen X-ray examination.

The button batteries lodged in the esophagus were removed by esophagoscope, and those in the gastrointestinal tract were under observation. Among 10 children with batteries in the first esophageal stenosis, 9 were cured and 1 suffered from tracheoesophageal fistula. One case of battery in the second esophageal stenosis was dead due to intercurrent aorto-esophageal fistula. Two cases of batteries in the third esophageal stenosis were cured after removal, and 1 case of the battery in the gastrointestinal tract discharged spontaneously.

Ingested button batteries are mainly lodged in the esophageal stenoses and are easy to cause esophageal injury and severe complications. Early detection, prompt treatment, strengthening observation and regular follow-up after discharge may help to decrease the incidence of complications and improve the outcomes.

Abbreviation: None.

Keywords: button battery, children, esophageal stenosis, gastrointestinal tract, ingestion

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Written informed consent for participation in the study was obtained where participants are children (under 16 years old) from their parents and this study was approval from the Ethics Committee of Children's Hospital Affiliated to Kunming Medical University (20190917001).

The authors have no conflicts of interest to disclose.

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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1. Introduction

Ingestion of foreign bodies is common in young children, especially in the children less than 5 years old.^[1,2] Button batteries are the second most frequently-ingested foreign bodies, secondary to the coins.^[3] Over the past two decades, the prevalence and mortality of button battery ingestion have been on the rise with an extensive application of smaller, more technologically advanced toys in the household.^[4] It was reported the prevalence of lithium battery ingestion increased from 1.3% to 24% of ingested button batteries between 1990 and 2008.^[5]

The battery can be divided into positive and negative poles, in which the former is made of various chemical substances including the lithium, oxygen, manganese, manganese dioxide, silver oxide or mercuric oxide, and the latter is made of lithium or zinc.^[6] The mucosa will bridge the positive and negative poles of the battery to form a local external current when a battery is lodged in the esophagus, which has been demonstrated to result in the hydrolysis and hydroxide formation, consequently leading to serious clinical complications within hours of ingestion, such as esophageal perforation, tracheoesophageal fistula and aorto-esophageal fistula.^[7,8]

For the children ingesting button batteries, early diagnosis and effective management contributes to decreasing the incidence of complications and improving the outcomes. In this study, the characteristics, complications and outcomes of 14 children with button batteries lodged in the upper gastrointestinal tract were

Table 1
Baseline characteristics, complications and outcomes of 14 children ingesting button batteries.

Site	No.	Battery		Fever	Dysphagia	Salivation	Vomiting	Abdominal pain	Diameter (mm)	Mucosal injury	Retention time of gastric tube (d)	Complications	Outcomes
		Age (mo)	retention time (h)										
1	1	17	52	Yes	Yes	Yes	No	No	22	E, S, ME and PM	136	TEF	Cure
	2	34	9	No	Yes	Yes	Yes	No	15	E and S	5	EI	Cure
	3	14	34	No	Yes	Yes	Yes	No	20	E and S	12	EI	Cure
	4	22	17	No	Yes	No	No	No	22	E, S and PM	25	EI	Cure
	5	15	5	No	Yes	Yes	Yes	No	18	H and S	6	EI	Cure
	6	16	99	No	Yes	No	Yes	No	13	E and S	7	EI	Cure
	7	31	12	No	Yes	No	No	No	22	H and S	7	EI	Cure
	8	11	24	Yes	Yes	Yes	Yes	No	15	E, S and PM	30	EI	Cure
	9	9	31	No	Yes	Yes	Yes	No	18	E, S and ME	16	EI	Cure
	10	9	15	No	Yes	Yes	Yes	No	22	E, S and H	11	EI	Cure
2	11	29	76	Yes	Yes	Yes	Yes	No	21	E, S, ME and PM	9	AEF	Death
3	12	85	13	No	No	No	No	Yes	21	E and S	7	EI	Cure
	13	15	4	No	Yes	Yes	No	Yes	20	E and S	12	EI	Cure
4	14	102	1	No	No	No	No	No	10	None	0	None	Cure

Notes: Site 1: the first esophageal stenosis; Site 2: the second esophageal stenosis; Site 3: the third esophageal stenosis; Site 4: the gastrointestinal tract. It should be noted that only 1 child had laryngeal stridor. AEF: aorto-esophageal fistula, E: mucosal erosion, EI: esophageal injury, H: mucosal congestion, ME: mucosal erythema, PM: mucosal attached pseudo membrane, S: mucosal swelling, TEF: tracheoesophageal fistula.

analyzed to emphasize the importance of early diagnosis and treatment.

2. Methods

2.1. Study population

Between 2017 and 2019, 14 children ingesting button batteries from Kunming Children's Hospital were involved in this study. The diagnosis was made primarily by the history of button battery ingestion, physical examination and chest-abdomen X-ray examination. All the children's parents were informed consent. This study was approved by the Institutional Review Board of Kunming Children's Hospital, The Children's Hospital Affiliated to Kunming Medical University (Approval No.: 20190917001).

2.2. Collection of basic information

The clinical data of children ingesting button batteries were recorded in detail, including the age, gender, battery retention time, battery diameter, battery lodging positions, presence or absence of fever, dysphagia, salivation, vomiting and abdominal pain, degree of mucosal injury, complications, and outcomes.

2.3. Operation procedures

The children in a supine position underwent endotracheal intubation for general anesthesia. Esophagoscopy: various models of Germany Storz children's hard esophagoscopes, model number: 10 mm × 12 mm × 20 mm and 12 mm × 14 mm × 30 mm; various models of Storz esophageal foreign body forceps and external Storz light source for illumination using a Mitsubishi mirror.

The ingested button batteries lodged in the esophagus were removed by esophagoscope under general anesthesia in emergency room. The children with button batteries in the gastrointestinal tract were under observation, the removal of button batteries under an esophagoscope or open surgery would be conducted if necessary. Postoperatively, the nasal feeding tube

was retained, and symptomatic treatments including anti-inflammation and nutritional support were performed. All the children were followed up until a normal diet or death.

3. Results

3.1. Basic characteristics, complications and outcomes

The basic characteristics, complications and outcomes of 14 children were listed in Table 1. There were 10 males and 4 females. Three cases were at the age of 1 year, 9 at the age of 1 to 4 years and 2 at the age of 5 years or older. The retention time of button batteries was 1 to 4 hour in 2 cases, 4 to 24 hour in 7 cases and >24 hour in 5 cases, respectively. The number of children with the diameter of button batteries <20 mm, =20 mm and >20 mm was 6, 2, and 6, respectively. The occurred symptoms included fever (3 cases), dysphagia (12 cases), salivation (9 cases), vomiting (8 cases), laryngeal stridor (1 case) and abdominal pain (2 cases); only one case was asymptomatic.

Among 13 cases of button batteries lodged in the esophagus, the esophageal mucosa of 11 cases were seriously erosive and those of other 2 cases were congestive and swollen. The button batteries in 10 cases were lodged in the first esophageal stenosis (Fig. 1A), in which 9 were cured after removal and 1 was complicated with tracheoesophageal fistula 4 days after removal (Fig. 2), but the fistula was healed by treatment. The button battery in 1 case was lodged in the second esophageal stenosis (Fig. 1B), and this child was dead due to intercurrent aorto-esophageal fistula 13 days after removal. Two cases of button batteries lodged in the third esophageal stenosis (Fig. 1C) were cured after removal. One case had the button battery lodged in the gastrointestinal tract (Fig. 1D), and the button battery discharged spontaneously in the following day, without any treatments.

3.2. Typical case presentation

One case of complication with tracheoesophageal fistula: This child was at the age of 17 months. The chest radiography showed

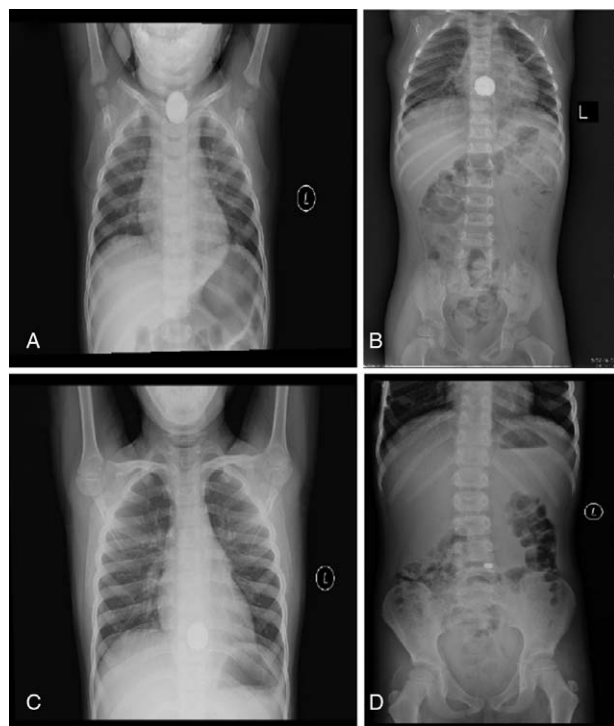


Figure 1. The button batteries in the upper gastrointestinal tract. Button batteries were lodged in the first (A), second (B) and third (C) stenoses of esophagus and in the gastrointestinal tract (D).

a circular metal-density shadow at the level of C7-T1. The retention time of button battery was 52 hours. A 22-mm-diameter lithium battery was taken out from esophagus. The child suffered from severe pneumonia on day 4 after operation, and was diagnosed as tracheoesophageal fistula (Fig. 2) through gastroscopy examination on day 12 after operation (Given the pneumonia due to tracheoesophageal fistula, we thought that tracheoesophageal fistula occurred on day 4 after operation). On day 16 after operation, the child was discharged from hospital with the nasal feeding tube after controlling pneumonia. During 136 days of follow up, the gastroscopy and bronchoscope examinations showed the tracheoesophageal fistula was healed.

Death case: A 29-month-old child suffered from the button battery lodged in the second esophageal stenosis. The child was

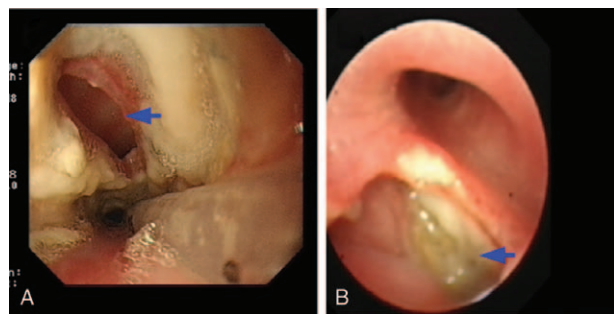


Figure 2. The child with the ingested button battery lodged in the first esophageal stenosis was complicated with tracheoesophageal fistula. (A) tracheoesophageal fistula under gastroscopy; (B) tracheal fistula under fiberoptic bronchoscopy.

taken to hospital due to fever and obvious vomiting in the second day. Chest radiography showed a circular high-density shadow at the level of T6–7. Preoperatively, the button battery remained in the body for 76 hours. A 21-mm-diameter lithium battery was taken out successfully using esophagoscope. The child was discharged from hospital with the symptom controlled. On day 13 after operation, the child suddenly spitted massive blood and was dead on the way of sending to the hospital. The autopsy result showed that the child died of hemorrhagic shock caused by severe bleeding due to the esophageal erosion and aorto-esophageal fistula.

Two cases of button batteries lodged in the third esophageal stenosis: The chief complaint was abdominal pain. The chest radiography showed a high-density shadow at the level of T11 and presence of possible foreign bodies in the lower segment of esophagus. Two button batteries (20 mm and 21 mm) were taken out using esophagoscope. Even though the esophageal mucosae were edematous and erosive, esophageal and cardiac stenosis did not occur in following weeks.

One case of the button battery lodged in the gastrointestinal tract: The thoracic and abdominal radiography showed that a sheet of high-density shadow was present in the superior margin of L5 in the middle abdomen, and the edge was smooth. A 10-mm-button battery discharged spontaneously within 24 hours. No gastrointestinal erosive signs and complications occurred.

4. Discussion

The typical manifestations of children ingesting button batteries are divided into three types, including:

- (1) irritability, anorexia, tarry stool and dysphonia in children below 1 years old;
- (2) fever, dyspnea, cough, salivation and vomiting in children aged 1 to 4 years old;
- (3) abdominal pain and chest pain in children above 5 years old.^[9]

The imaging results showed that the ingested button battery was usually presented to be a typical “double ring” in anteroposterior posture and a “step-off” shadow in the lateral posture.^[10,11] All the children ingesting button batteries can be diagnosed through medical history and the imaging results. Button batteries tend to lodge in the stenosis of esophagus around which the trachea, mediastinum and great vessels exist. In addition, the damage of esophagus, as an important passage of feeding, can result in serious complications including spondylitis,^[12] esophageal perforation,^[13] esophageal stenosis, tracheoesophageal fistula,^[14] aorto-esophageal fistula^[15] and vocal cord paralysis.^[16–18] In our study, 13 out of 14 cases had button batteries lodged in the esophageal stenoses, among whom 11 suffered from esophageal injury, 1 from tracheoesophageal fistula and 1 from aorto-esophageal fistula as presented in Table 1. Gao et al. reported that the rinsing under endoscope can effectively improve the prognosis of patients with esophageal injury related to foreign bodies.^[19] To reduce the esophageal injury caused by button batteries, the children in our study immediately drank the acid beverages to neutralize alkaline substances after ingesting button batteries. Intraoperatively, we used a large amount of normal saline combined with vitamin C solution to rinse the esophageal wound to further reduce the damage of residual alkaline electrolytes to the esophagus.

The button battery is apt to cause a short circuit under the circumstance of moist esophagus, and then starts to electrolyze, discharge and release alkaline substances to damage the body. These erosive and perforating effects may also continue even after removing button batteries.^[17,20] Therefore, the corresponding measures including gastrointestinal decompression, fasting and nasal feeding should be taken postoperatively according to complications and disease severity. Gastrointestinal decompression can accelerate the wound recovery by reducing the regurgitation of gastric contents to the esophagus, and omeprazole is intravenously injected to prevent the regurgitation of gastric juice and protect digestive mucosae. For patients with mild complications, the fasting of 1 to 2 days is adopted, while for those with severe complications, the fasting time is based on the perforation size and recovery condition of tracheoesophageal fistula. Moreover, the nasal feeding diet should be reasonable in nutrition to promote the wound healing. In our study, 1 case died of hemorrhagic shock due to the esophageal erosion and aorto-esophageal fistula. Massive hemorrhage may be associated with the rupture of arterial walls corroded by batteries. The death cause may be attributed to inadequate risk assessment of medical staff and parents on hemorrhage and neglect of the massive hemorrhage risk in large vessels corroded by batteries. Thus, during the treatment, we should closely observe whether the symptoms of severe digestive injury occur, such as fever, vomiting, abdominal pain, tarry stool, and more.

The window of opportunity for injury-free removal of an esophageal battery is <2 hours.^[5] In our study, the retention time of all batteries was over 2 hours. The retention time of 2 children with esophageal fistula was respectively 55 hours and 76 hours, significantly longer than those without esophageal fistula (except No. 6 child), suggesting that the battery retention time may be an important influencing factor for the formation of esophageal fistula. Previous studies have shown that esophageal mucosal injury and bleeding even esophageal perforation can occur 2 hours after ingestion of button batteries, and the risk of severe complications like tracheoesophageal fistula, esophageal perforation and aortic hemorrhage significantly increases if the retention time is greater than 24 hours.^[5,21] Accordingly, the retention time of button batteries in the body should be shortened as soon as possible to decrease the incidence of postoperative complications.

According to the guidelines for the management of ingested foreign bodies in the gastrointestinal tract in 2002, it was unnecessary to take out the batteries below the esophagus unless the symptoms and signs of gastrointestinal injury appeared, or a large-diameter battery (>20 mm in diameter) remains in the stomach for more than 48 h by repeated X-ray examinations.^[22] In 2015, North American Society for Pediatric Gastroenterology, Hepatology and Nutrition Endoscopy Committee also proposed that the children with the following factors, such as 5 years older or above, short duration of ingestion (<2 hours), size of the battery <20 mm, absence of clinical symptoms, should be observed alone.^[23] Various digestive juices and enzymes in gastric acid and gastrointestinal tract can neutralize alkaline substances released by the battery, which reduce the corrosive effect of batteries. Additionally, the button batteries passing beyond esophagus are uneasy to lodge in the gastrointestinal tract. In our study, the button battery lodged in the gastrointestinal tract of 1 case was found to discharge spontaneously. However, our findings remained to be further concerned due to the limitations in a retrospective and descriptive case-series study.

5. Conclusions

Ingested button batteries are mainly lodged in the esophageal stenoses and are easy to cause esophageal injury and severe complications. Early detection, prompt treatment, strengthening observation and regular follow-up after discharge may help to decrease the incidence of complications and improve the outcomes.

Author contributions

Y.G and J.W were responsible for designing the concept and writing the article; J.M, Y.G, T.Z, P.L, and X. X. participated in data collection and data analysis; Y.G was involved in supervising the article. The final article was approved by all the authors.

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