

Treatment and consequences of battery ingestion based on case of child with battery lodged in esophagus for 6 months period

Leczenie i powikłania połknięcia baterii na podstawie przypadku dziecka z zaklinowaną przez 6 miesięcy baterią w przełyku

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KEYWORDS

button battery, esophageal foreign body, esophageal burn

SUMMARY

The incidence of button battery ingestions in children increases significantly due to widespread availability of battery-powered devices. Nowadays, lithium-ion batteries with higher current voltage are increasingly being used. They create a greater risk of getting lodged in the esophagus due to their larger diameter. Batteries cause severe injuries leading to life-threatening complications like esophageal stenosis or perforation, tracheoesophageal fistula, vocal cord paralysis, vascular fistula leading to hemorrhage and death. Severe complications are present in 12% of children under 6 years of age. Life-threatening consequences arise as a result of prolonged exposure of esophageal mucosa to battery. The study presents a case of 1.5 year-old girl with significant underweight, dysphagia and dysphonia caused by button battery lodged in esophagus for six months. This is first and only study describing survival with button battery for so long. The presentation of symptoms, radiological findings, treatment and clinical outcomes were described. Reviewed literature was analyzed.

SŁOWA KLUCZOWE

bateria guzikowa, ciało obce przełyku, oparzenie przełyku

STRESZCZENIE

Ilość przypadków połknięcia baterii uległa wielokrotnemu zwiększeniu w ciągu ostatnich dekad w związku z łatwą dostępnością urządzeń i zabawek zasilanych bateriami. Współcześnie używa się coraz częściej większych rozmiarów baterii litowo-jonowych mających wyższe napięcie prądu, które ze względu na większą średnicę stwarzają większe prawdopodobieństwo zaklinowania się w przełyku. Do powikłań ekspozycji przełyku na baterię zaliczamy: perforację przełyku, przetokę przełykowo-tchawiczą, perforację aorty, przetoki dużych naczyń, zapalenie śródpiersia, porażenie fałdów głosowych, uszkodzenie kręgosłupa i zgon. Ciężkie powikłania rozwijają się u 12% dzieci poniżej 6. roku życia. W pracy przedstawiono przypadek dziecka, które przeżyło z baterią w przełyku przez pół roku. Główną dolegliwością było zaburzenie połykania i skrajne niedożywienie. Bateria litowo-jonowa o średnicy 20 mm utknęła typowo w górnym naturalnym przewężeniu przełyku. Nie opisano do tej pory w literaturze przypadku tak długiego zalegania baterii w przełyku. W pracy przedstawiono przebieg kliniczny, diagnostykę, leczenie i możliwe powikłania w odniesieniu do danych dostępnych w literaturze.

INTRODUCTION

Accidental ingestion of foreign bodies is a very common incident in the child population. Most swallowed foreign bodies pass through the gastrointestinal tract without major discomfort or complications. Intervention is required for

objects lodged in the gastrointestinal tract, especially in its narrowest section – the esophagus. Esophageal foreign bodies are localized in one of three esophageal constrictions – most often they are at the level of the upper esophageal sphincter (60-70%), in the middle section of the esophagus,

at the junction with the aortic arch (10-20%) or above the lower esophageal sphincter (20%) (1, 2). Urgent diagnosis and removal of batteries is required because they pose a threat to the patient's life. The number of battery ingestion cases has increased multiple times in recent decades due to the easy availability of battery-powered devices and toys. Nowadays, larger sizes of lithium-ion batteries called button batteries (> 15 mm in diameter) are increasingly used. Such batteries have a higher current voltage and create a greater risk of getting lodged in the esophagus due to their larger diameter (2). It is crucial to identify and remove the battery as soon as possible to avoid life-threatening complications. 80% of all swallowed foreign bodies that require removal involve children between the ages of 6 months and 3 years, as the diameter of their esophagus is small enough to facilitate a foreign body getting lodged in its lumen (3-6). The most commonly reported complaints are swallowing disorders and pain during swallowing. Coughing, choking, sore throat, fever, respiratory distress, drooling, vomiting, and general restlessness and irritability of the child may also be present. In young children, a foreign body in the esophagus may be asymptomatic or cause nonspecific complaints (7-10). The presence of a battery in the esophagus is always a life-threatening condition. Diagnostics is based on an X-ray with anteroposterior and lateral projections of the neck and chest, and if necessary, the abdominal cavity. The button battery shows a pathognomonic double-ring sign or a halo sign in AP view and step-off sign in the lateral view (11, 12). The battery in its structure has electrolyte compartments to generate electricity from a chemical reaction. Each electrochemical cell consists of anode (negative pole) and cathode (positive pole) compartments. The composition of lithium-ion batteries includes manganese, cobalt, nickel and lithium ions (8, 13). Batteries lacerate the esophageal wall by four different mechanisms. The first involves compression of the foreign body against the esophageal wall. The pressure causes ischemia and the formation of sores, followed by necrosis and eventual perforation. This mechanism applies not only to batteries, but also to all foreign bodies lodged in the esophageal lumen. The second mechanism is based on electrical discharge, hydroperoxide release and alkali burn of the gastrointestinal wall. Another mechanism involves the leakage of toxic substances causing chemical burn (10, 14-18). Leakage of electrolytes from the battery is facilitated by a humid environment. In *in vitro* studies, even immersion of the battery in saline confirmed its spillage and leakage of contents. The fourth mechanism is poisoning of the body by absorption of toxic substances mainly mercury compounds through the intestinal wall into the bloodstream (14, 15, 17). The duration of exposure of the esophageal wall to the battery has the greatest prognostic significance (16). Complications of esophageal exposure to the battery include esophageal perforation, hemorrhage, esophageal-tracheal fistula, aortic perforation, large vessel fistulae, mediastinitis, vocal fold paralysis, spinal injury and

death (7, 8, 18-21). Severe complications are present in 12% of children under 6 years of age (17, 22, 23).

CASE REPORT

The 18-month-old girl was transferred from the pediatrics department, where she was diagnosed with severe underweight (7.3 kg body weight, 74 cm height, 0 percentile) and swallowing disorders with hoarseness. Dysphagia and lack of weight gain had persisted for more than 6 months. The referring pediatrician also reported a pending lawsuit in family court due to the mother's negligence in caring for the child. A chest X-ray showed a foreign body with a characteristic "halo" sign in the upper (cervical) esophageal constriction (fig. 1).



Fig. 1. X-ray of the chest

The child was qualified for endoscopy of the airway and esophagus. The endoscopic examination revealed small 1st degree laryngeal cleft (fig. 2) and stenosis in the upper trachea (obstruction of 60% of the tracheal lumen) due to protrusion of the posterior tracheal wall caused by external pressure (fig. 3).

Esophagoscopy showed slight resistance when the endoscope was inserted into the esophagus. The upper part of the esophagus showed irregular, fibrous, easily bleeding mucosa and granulation tissue. A metallic foreign body was visualized in the anterior wall of the esophagus, which was lodged and surrounded by scar and inflammatory granulation tissue. Using a flexible and rigid endoscope during a 3-hour procedure, the scar tissue and granulation tissue were initially excised, and then the foreign body, which was ingrained in the esophageal wall, was mobilized and removed. Numerous attempts to grasp the foreign body

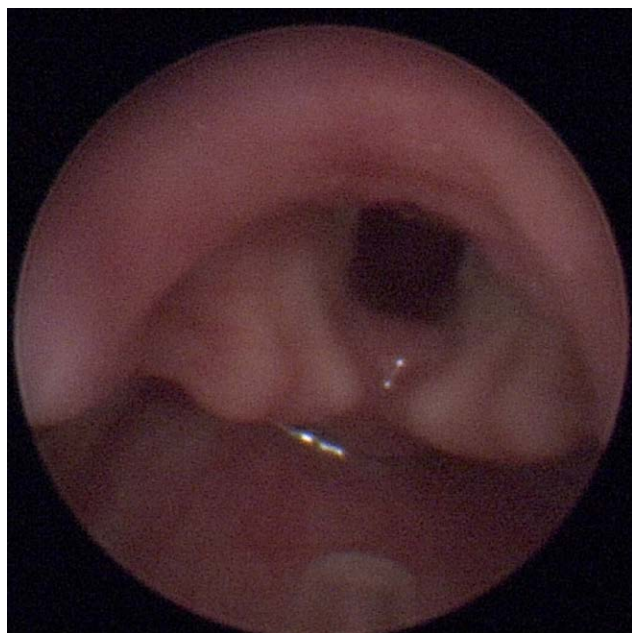


Fig. 2. Laryngeal cleft

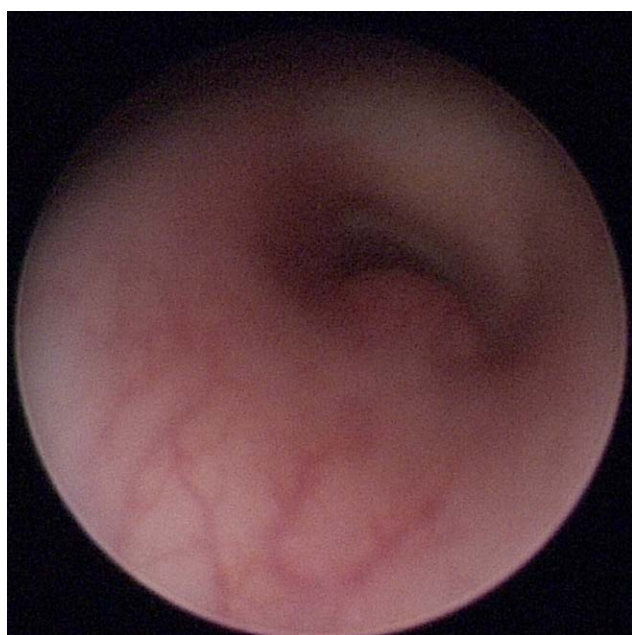


Fig. 3. Endoscopy of trachea with an intruding foreign body from the esophagus

with forceps during esophagoscopy led to pulling off and removing the protective plastic membrane from the battery. After removal of the battery, there were no obvious features of alimentary tract perforation, but accurate assessment was limited by massive swelling of the esophageal tissues. Extensive decubitus and bleeding inflammatory granulation tissue were visualized at the site of the battery ingrowth. Below the lodged foreign body a normal image of the esophagus up to the gastric antrum was found. Due

to massive swelling of the esophagus, larynx, as well as the pharynx and neck, the child was transferred for 48 hours observation in the intensive care unit. After the procedure, antibiotic therapy (ceftriaxonum iv) and anti-reflux treatment (omeprazole iv) were administered. Three hours after the procedure, a chest x-ray was performed, revealing no signs of esophageal perforation. After 2 days, oral nutrition was implemented with no solid food swallowing disorders. The child was transferred to the primary pediatrics department, but the girl's mother did not consent to further hospitalization - the case was reported to the legal and social services department. Due to the lack of cooperation with the child's mother, it is not possible to perform a follow-up esophageal endoscopy (fig. 4).



Fig. 4. Esophageal foreign body – button battery

DISCUSSION

The presence of a battery in the esophagus requires urgent diagnosis and removal because it is a life-threatening condition. This paper presents the case of a child who survived with a battery in the esophagus for more than six months. The main complaint was swallowing disorder, which caused extreme malnutrition. The 20-mm-diameter lithium-ion battery was typically lodged in the upper natural constriction of the esophagus. A case of battery lodged in the esophagus for such a long period of time has not been reported in the literature so far. The extension of the lesion depends on the duration of contact between the battery and the esophageal mucosa, the pressure of the foreign body exerted on the esophageal wall, the local current flow, and the leakage of substances from the battery (18). Taking into account as many as 4 possible pathomechanisms of damage – changes visible on the mucosa appear as early as 15 minutes, and necrosis of the esophageal wall is found after 12 hours of exposure to the battery (8, 24). In the observations presented by Kimball et al. conducted on 10 patients with battery in the esophagus, gastrointestinal perforation occurred in 2 cases. The duration of contact between the battery and the esophageal wall was an significant factor.

In the study, esophageal perforation occurred in a child with a battery removed on seventh day after intake. The child with a battery lodged in the esophagus for 30 days

resulted in a formation of an esophageal-tracheal fistula. Extensive trauma to the esophageal wall should always raise the suspicion of a fistula, and therefore bronchoscopy with tracheal evaluation is indicated in such cases (7). Fatal cases have also been described. A swallowed battery from a camera eroded into the esophagus eventually leading to hemorrhage from the inferior thyroid veins and death of the patient (19). A study conducted on animals found damage to the esophageal mucosa 1 hour after ingestion, combustion of all muscle layers was found 4 hours after the beginning of exposure to the battery (18, 20). A study by the Yoshikawa et al. found a correlation between the esophageal wall and exposure to the negative (anode) side of the battery (16). The most common remote complications after hours or days of button battery lodging in the esophagus are stenoses of its lumen. The incidence of such strictures is underestimated because routine follow-up endoscopies are not performed several weeks after the event (23). The paper by Fuentes et al. describes 2 cases of esophageal strictures in three patients with a battery lodged in the esophagus for several hours (17). Long-term follow-up with endoscopy is recommended at least 4 weeks after removal of the battery (7). The literature also describes a case of bilateral vocal fold paralysis as a remote complication that occurred one month after esophageal button battery evacuation in a child (21). An interesting case is a patient with cardiac arrhythmias and ECG changes (ST-segment elevation, higher amplitude of leads, two-phase T-wave, QT-segment prolongation) caused by electrically active swallowed batteries due to a suicide attempt (25). The composition of lithium-ion batteries mainly includes manganese, cobalt, nickel and lithium ions. Depending on the type of battery, compounds of aluminum, cadmium, chromium, copper, iron, mercury, magnesium, lead, zinc, tungsten, vanadium, antimony, strontium, thallium, tin and barium were also found in their composition. A paper by Rebhandl et al. on the effects of gastric acid on batteries presented leakage from almost all 8 types of batteries analyzed after just 4 hours. The highest leakage was for cadmium, mercury and lead (14). The electrochemical composition of the battery is responsible for extensive tissue damage if it comes into contact with the battery. More susceptible to damage is the esophageal wall adjacent to the negative pole of the battery (anode), where the electrical potential induces a water hydrolysis reaction. The production of hydroxide ions, electrolysis of tissues, elevation of pH to 12-13 and tissue lysis rapidly produces liquefaction necrosis of the esophageal wall (8). There have been many in vivo and in vitro studies evaluating the effects of various agents (honey, edible oil, sucralfate, saline, acidic fruit juices) on the process of mucosal damage by the lodged battery (24, 26). A better protective effect can be achieved by combining oil with honey (1:1). The poor viscosity of the oil makes it flow quickly from the battery toward the stomach due to peristalsis. Honey at body temperature has

50 times better viscosity and stays longer on the battery in the esophagus (27). Admission of honey or sucralfate to neutralize the pH on the surface of tissues exposed to the electrically active battery is recommended before arrival at the hospital. This reduces the risk of lesions to the esophageal wall (8, 26, 28, 29). The dosage of prophylactic agents after the discovery or suspicion of battery ingestion was developed by the National Capital Poison Center (30). It recommends oral administration of 10 ml of sucralfate (1 g/10 ml suspension) every 10 minutes for up to 3 doses (30). Alternatively, in children older than 12 months can intake 2 teaspoons of honey orally every 10 minutes for up to 6 doses. These substances work by lowering the pH, and also coat the battery to prevent local hydroxide production and chemical burns (inhibit and reduce the caustic reaction). Taking the above agents should not delay the foreign body removal procedure (30). Taking honey or sucralfate does not affect a child's ability to remain fasting for planned general anesthesia (31). Prophylactic lavage is also recommended during esophagoscopy. After removal of the battery and in case of no perforation is found, it is recommended to flush the battery-exposed tissues with 50-150 ml of sterile 0.25% acetic acid solution. The procedure is intended to neutralize the alkaline pH and suppress the progressive alkali burn process (8, 30, 32). After removal of the foreign body from the esophagus recommendation includes feeding by gastric probe, intravenous antibiotic and steroid therapy, anti-reflux treatment with proton pump inhibitors. These prevention is recommended until further damage or complications are ruled out. Pain medication is administered as needed. A chest X-ray is indicated up to 2 days after removal of the battery. If a chemical burn of the esophagus is identified, a follow-up esophagoscopy should be performed after 4 weeks of the injury to rule out esophageal strictures (7, 13). Nowadays, some battery manufacturers coat button batteries with a layer of a very bitter substance called Bitrex. This substance is non-toxic and completely harmless when ingested. It has found widespread use in household products to prevent inadvertent ingestion. Additional safety feature is the double plastic packaging that can only be removed with scissors. They also have a sticker on the battery. Presumably, it was this sticker that protected the battery from leakage of the battery or induction of electrical activity for a period of 6 months in the case of the patient described in this report.

CONCLUSIONS

It is extremely important to prevent battery ingestion incidents by ensuring that children do not have access to batteries. It is necessary to educate parents about the harmfulness of batteries and the need for early medical intervention even when ingestion is only a suspicion. Consideration should also be given to introducing generalized recommendation for the safety of button batteries (bitter coating or protective layers).

CONFLICT OF INTEREST
KONFLIKT INTERESÓW

None

Brak konfliktu interesów

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