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Tracheoesophageal fistula following button battery ingestion in an infant

Airway management considerations

Case

A 13-month-old male infant (weight 9.1 kg) was seen in a primary clinic with swallowing and feeding problems that had persisted for 3 weeks. Chest X-ray examination showed a flat and round hyperdensity measuring 21 mm in diameter at the level of the tracheal bifurcation, identified to be a button battery. Shortly after hospital admission, the child developed severe respiratory distress requiring tracheal intubation and mechanical ventilation (■ Fig. 1). Suspected pulmonary infection and me-

diastinitis were treated with intravenous meropenem (3 doses of 250 mg). The child was transferred to a tertiary pediatric center nearly 1000 km away.

A thoracic computed tomography (CT) scan showed that the battery had eroded the esophagus and was in immediate contact with the trachea, exerting external pressure on the right main bronchus, which was partially occluded and on the right main pulmonary artery. Mediastinal effusion was also seen (■ Fig. 2). The decision was made to surgically remove the button

battery and surgery was scheduled for the next day.

Upon arrival in the operating room, diagnostic bronchoscopy was performed with a 2.8 mm external diameter flexible scope. The main finding was that the battery had eroded the posterior tracheal wall slightly above the carina and was partially visible in the tracheal lumen. Based on these findings, the surgical plan was to perform median sternotomy, extract the battery and repair the esophageal and tracheal lesions. Several airway management options were discussed with a final interdisciplinary decision to

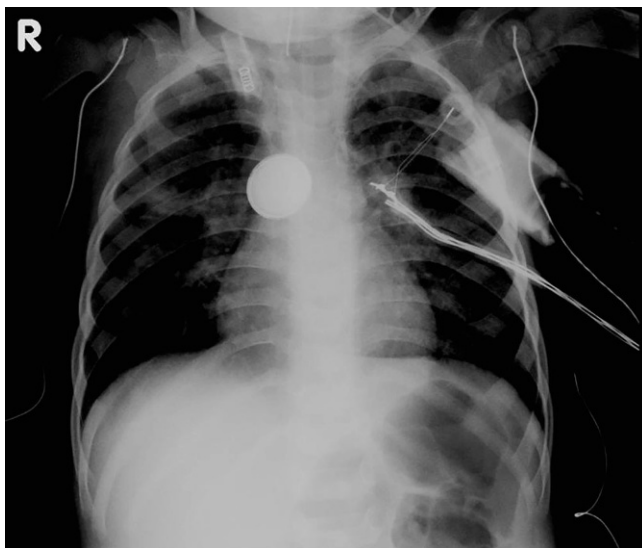


Fig. 1 ▲ Anteroposterior X-ray showing the button battery. Note the distinctive double ring or halo sign

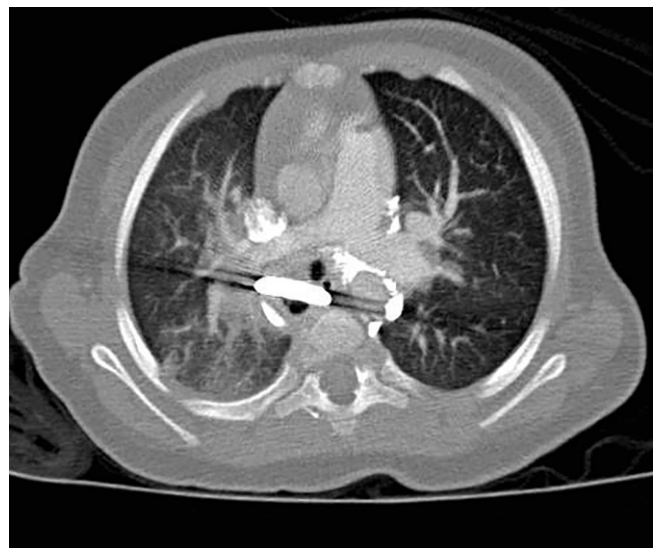


Fig. 2 ▲ Contrast-enhanced thoracic axial CT scan showing the button battery at the level of the carina

perform surgery on cardiopulmonary bypass. An arterial line was inserted in the left femoral artery, and a triple-lumen central venous catheter was placed in the right internal jugular vein. After median sternotomy and administration of heparin (400 units/kg body weight), the superior and inferior vena cavae and ascending aorta were individually cannulated. Once a blood-primed cardiopulmonary bypass with 100% flow (2.5 l/min/m²) was established, the target structures were exposed and the battery was uneventfully removed. While the esophageal lesion was easy to repair with simple sutures, the low tracheal lesion required technically sophisticated reconstruction, including three periods (4, 22, and 25 min, respectively) during which pump flow was reduced to 10% to reduce the filling of the aorta, which was obstructing the surgical field when full flow was used. During this period the body core temperature was decreased to 25.1 °C. After 142 min the child was weaned from cardiopulmonary bypass, received protamine, two units of cryoprecipitate and platelets. The child was transferred to the pediatric intensive care unit and after repeat bronchoscopy was extubated and moved to the peripheral unit on postoperative day 3 in a stable condition and without obvious neurological or infectious sequelae.

Discussion

According to the United States National Electronic Injury Surveillance System, the average annual battery-related emergency department visit rate was 4.6 visits per 100,000 children from 1990 to 2009. Battery ingestion accounted for 76.6% of emergency department visits, followed by nasal cavity insertion, mouth exposure resulting in chemical burns, and ear canal insertion [1]. The typical age of children ingesting batteries is between 6 months and 4 years [2]. These patterns are also reflected by local data, in which batteries account for approximately 5% of ingested foreign bodies [3]. While most batteries will pass through the gastrointestinal tract spontaneously, severe morbidity and fatality can occur if the battery lodges in the esophagus. In

a large multicenter case series from the USA, 13 deaths have been reported in 56,535 observed button battery ingestions, all in children under 3 years of age and after unrecognized ingestion or delayed treatment [4].

According to recent interdisciplinary guidelines, foreign bodies blocking the esophagus are considered medical emergencies. This is of specific concern with batteries, where current flow can cause profound burns after just 1–2 h [5]. Possible complications of delayed treatment include mucosal lesions with subsequent esophageal strictures, tracheoesophageal and aorto-esophageal fistulas and mediastinitis. In the anteroposterior X-ray, button batteries show a typical double-ring or halo sign (■ Fig. 1). This is caused by the near-edge interruption of the metal sheath for the nonmetallic insulation between the poles. In case of doubt, even in the absence of this double-ring sign, it should be assumed that a round foreign body is a battery and not a coin.

The mechanism of damage caused by batteries is based on the flow of current and the resulting formation of hydrochloric acid at the anode (positive pole) and sodium hydroxide at the cathode (negative pole). In addition, the flow of current may cause a contraction of the esophageal musculature, which prevents further movement of the battery into the stomach. Thus, sodium hydroxide swiftly accumulates in one place and causes liquefactive necrosis, comparable to an alkaline caustic ingestion injury [7, 8].

The lateral X-ray can be helpful if a step-off can be noted, as seen with some batteries. The narrower part of the battery corresponds to its negative pole and can help guide clinicians to where the most severe tissue injury due to hydroxide accumulation may occur and what potential complications need to be considered in the patient, e.g. spondylodiscitis if the negative pole faces posteriorly. Furthermore, severity of local injury directly corresponds to the voltage of the battery [1, 7]. Since the individual response of the tissue to the chemical damage is highly variable, perforation with subsequent mediastinitis or fistula formation into adjacent vital structures can

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Tracheoesophageale Fistula following Button Battery Ingestion in an Infant. Airway Management Considerations

Abstract

A 13-month-old infant was admitted to hospital approximately 3 weeks after ingestion of a button battery, which was lodged in the esophagus and had caused a tracheoesophageal fistula requiring mechanical ventilation. Since the battery had partially penetrated into the tracheal lumen just above the carina and also was in direct contact with the pulmonary artery, extensive considerations regarding airway and circulatory management were required preoperatively, which are presented and discussed in this case report.

Keywords

Jet ventilation · Lung separation · Cardiac arrest · Deep hypothermia · Low tracheal surgery

Tracheoösophageale Fistel nach Ingestion einer Knopf-Batterie bei einem Säugling. Implikationen für das Atemwegsmanagement

Zusammenfassung

Ein 13-monatiger Säugling stellt sich etwa 3 Wochen nach Ingestion einer Knopf-Batterie vor, welche im Ösophagus steckengeblieben war und eine tracheoösophageale Fistel mit Beatmungspflichtigkeit verursacht hatte. Da die Batterie die Tracheahinterwand knapp oberhalb der Carina perforiert und zudem unmittelbaren Kontakt zur Pulmonalarterie hatte, waren präoperativ umfangreiche Überlegungen zum Atemwegs- und Kreislaufmanagement erforderlich, die in dieser Kasuistik dargestellt und diskutiert werden.

Schlüsselwörter

Jetventilation · Seitengetrennte Intubation · Kreislaufstillstand · Tiefe Hypothermie · Trachealchirurgie

occur with a latency of up to 14 days [8]. Therefore, esophageal perforation should be ruled out on the first day (and repeatedly if deemed necessary) after removal of the battery with appropriate examinations, e.g. contrast esophagram or magnetic resonance imaging (MRI) [7, 8]. In the low-resource setting in which the case presented, the parents sought medical assistance for their child only 3 weeks after ingestion, when feeding disorders and respiratory distress became unbearable. Upon admission to a rural, primary care center, the child was in a life-threatening condition requiring immediate transfer to a large pediatric center. Based on the radiographic and bronchoscopic findings, the need for sophisticated surgical repair of a low tracheal lesion was highly likely. Preoperatively, different airway management options were discussed by the team of anesthesiologists and cardiothoracic surgeons. Firstly, any type of endotracheal tube in the surgical field would have interfered with the procedure. One option was to place a small-bore ventilation catheter through the endotracheal tube and jet-ventilate the infant. This option was considered dangerous, because flow of 100% oxygen through the surgical area combined with use of electrocautery posed a fire risk. Furthermore, it was uncertain if a 9 kg infant could be sufficiently oxygenated and decarboxylated over a lengthy period by means of manual jet ventilation alone. High frequency jet ventilation was not available. A second approach discussed was to dissect both main bronchi and have the surgeon intubate them separately, which is an option described for low tracheal or carinal surgery in adults [6]. This would have required two synchronized ventilators or both tubes connected to one ventilator via a Y-piece and put the child at the subsequent risk of anastomotic leak or bronchial strictures. This option was vetoed by the surgeons, however, as the endotracheal and ventilator tubes would have significantly interfered with surgical exposure. Therefore, the team elected to perform surgery on cardiopulmonary bypass. Again, two options were discussed. The first was to establish venoarterial extracorporeal membrane oxygenation through the femoral vessels. Because ad-

equate blood flow (particularly venous drainage) is often challenging in children <5 years of age and/or <20 kg [9, 10], thoracic cannulation of the large vessels through a median sternotomy was used instead. Finally, because the battery was in tight contact with the right pulmonary artery, thoracic cannulation that provided the option of completely stopping pulmonary blood flow was considered safest. Retrospectively, performing the procedure on cardiopulmonary bypass with thoracic cannulation was the best decision because the aortic arch interfered with the exposure of the tracheal structures. This problem was solved by temporarily reducing the pump flow from 100% (2.5 l/min/m²) to 10% resulting in functional hypothermic cardiac arrest.

In summary, button battery ingestion in an infant resulted in tracheoesophageal fistula that required low tracheal surgery, which presented a challenge to the entire team in terms of surgery, airway management and perfusion strategies.

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Compliance with ethical guidelines

Conflict of interest R.Hofmeyr, K.Bester, A.Willms, J.Hewitson and Prof. Dr. med. C. Byhahn declare that they have no competing interests.

For this article no studies with human participants or animals were performed by any of the authors. All studies performed were in accordance with the ethical standards indicated in each case. Additional written informed consent was obtained from all individual participants or their legal representatives for whom identifying information is included in this article.

References

1. Sharpe SJ, Rochette LM, Smith GA (2012) Pediatric battery-related emergency department visits in the United States, 1990–2009. *Pediatr Electron Pages* 129:1111–1117
2. Kramer RE, Lerner DB, Lin T, Manfredi M, Shah M, Stephen TC, Gibbons TE, Pall H, Sahn B,

McOmber M, Zacur G, Friedlander J, Quiros AJ, Fishman DS, Mamula P (2015) Management of ingested foreign bodies in children: a clinical report of the NASPGHAN Endoscopy Committee. *J Pediatr Gastroenterol Nutr* 60:562–574

3. Delport CD, Hodkinson PW, Cheema B (2015) Investigation and management of foreign body ingestion in children at a major paediatric trauma unit in South Africa. *Afr J Emerg Med* 5:176–180
4. Litovitz T, Whitaker N, Clark L, White NC, Marsolek M (2010) Emerging battery-ingestion hazard: clinical implications. *Pediatr Electron Pages* 125:1168–1177
5. Eich C, Laschat M, Becke K, Höhne C, Nicolai T, Hammer J, Deitmer T, Sittel C, Bootz F, Jungehülsing M, Windfuhr J, Schmittenebecher P, Schubert KP, Claßen M (2016) S2k-Leitlinie: Interdisziplinäre Versorgung von Kindern nach Fremdkörperaspiration und Fremdkörperingestion. *Anaesth Intensivmed* 57:296–306
6. Saroa R, Gombar S, Palta S, Dalal U, Saini V (2015) Low tracheal tumor and airway management: an anesthetic challenge. *Saudi J Anaesth* 9:480–483
7. Jatana KR, Litovitz T, Reilly JS, Koltai PJ, Rider G, Jacobs IN (2013) Pediatric button battery injuries: 2013 task force update. *Int J Pediatr Otorhinolaryngol* 77:1392–1399
8. Kaufmann J, Laschat M, Wappler F (2018) What to do when a child is choking? *Anaesthesiol Intensivmed Notfallmed Schmerzther* 53:48–60
9. Rollins MD, Hubbard A, Zabrocki L, Barnhart DC, Bratton SL (2012) Extracorporeal membrane oxygenation cannulation trends for pediatric respiratory failure and central nervous system injury. *J Pediatr Surg* 47:68–75
10. Coskun KO, Popov AF, Schmitto JD, Hinz J, Kriebel T, Schoendube FA, Ruschewski W, Tirilomis T (2010) Extracorporeal circulation for rewarming in drowning and near-drowning pediatric patients. *Artif Organs* 34:1026–1030