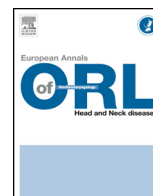




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Original article

## Esophageal lesions following button-battery ingestion in children: Analysis of causes and proposals for preventive measures

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### ABSTRACT

**Objectives:** To study recent cases of esophageal injury due to button-battery ingestion in children presenting in pediatric ENT emergency departments of the Paris area of France (Île-de-France region), in order to propose appropriate preventive measures.

**Material and method:** A retrospective descriptive single-center study included all children under 15 years of age, presenting in pediatric ENT emergency departments between January 2008 and April 2014 for button-battery ingestion with esophageal impaction requiring emergency removal.

**Results:** Twenty-two boys and 4 girls, with a median age of 25 months, were included. Twenty-five of the 26 batteries had diameters of 20 mm or more. Median esophageal impaction time was 7 hours 30 minutes (range, 2 to 72 hours). The complications rate was 23%. Mean hospital stay cost was €38,751 (range, €5130–119,737). The origin of the battery was known in 23 of the 26 cases: remote control without screw-secured compartment (42.3%), open battery pack (15.4%), children's toy (15.3%), camera (7.7%), watch (1 case) and hearing aid without screw-secured compartment (1 case).

**Conclusion:** Esophageal lesions due to ingestion of button-batteries in children are almost always due to batteries larger than 20 mm in diameter, mostly from devices with a poorly protected compartment, or batteries that are not individually packaged. These lesions cause serious complications in a quarter of cases and their management entails high health costs. Legislation requiring screw-secured compartments and individual blisters for batteries could have prevented 69.2% of the ingestions.

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### 1. Introduction

Ingestion of foreign bodies is an everyday cause of consultation in pediatric and pediatric ENT departments [1]. Flat, round and button-batteries require particular attention, as they may lead to severe or even fatal complications [2,3].

Ever more everyday devices, within reach of children at home, use such batteries, increasing the risk of ingestion [4]. Some batteries transit through the upper gastrointestinal tract, to be excreted some days later [5]. Others, with diameter exceeding 20 mm, are liable to get stuck in the esophagus, and may cause esophageal lesions of varying severity. There are various lesion mechanisms: caustic (alkaline electrolyte release), electrical (burns due to current induced between the mucosa and a battery with residual charge), mechanical (necrosis by mucosal compression), and thermic or toxic (local absorption of lithium or mercury from the battery).

These lesions can be life-threatening, and button-battery ingestion requires emergency diagnosis and emergency treatment by extraction [3,6].

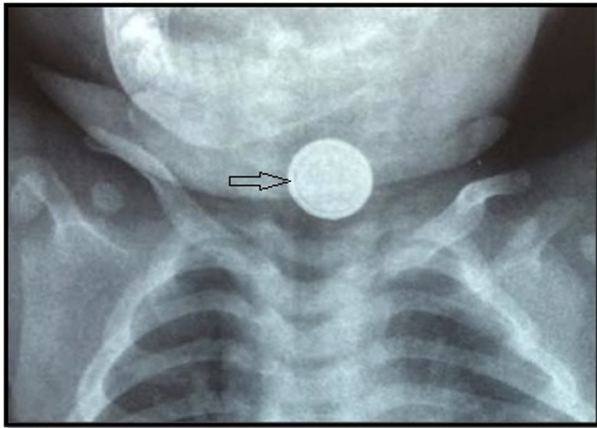
The aim of the present study was to collate recent data on the causes and severity of esophageal lesions caused by button-battery ingestion in children, with a view to proposing measures to reduce the incidence of accidental ingestion and updating European legislation in favor of prevention.

### 2. Material and methods

A retrospective descriptive single-center study included all children under 15 years of age managed in the pediatric ENT emergency department of the Necker Hospital for Sick Children, serving the Paris region of France (Île-de-France), between January 2008 and April 2014, for button-battery ingestion with esophageal impaction requiring emergency extraction. Cases of impaction in the pharynx or beyond the lower esophageal sphincter or of ingestion of foreign bodies other than button-batteries were excluded. Eligible cases were identified from the hospital's medico-administrative diagnosis-coding database. Medical files provided epidemiological

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**Fig. 1.** AP chest X-ray with double-contour aspect of the battery stuck in the superior third of the esophagus.

data (age at consultation, gender, history, and details of the ingestion and battery), clinical signs, impaction duration, esophageal location (superior sphincter, superior, middle or inferior third), lesion description, means of treatment, progression and complications.

Diagnosis of button-battery ingestion with esophageal location was based on clinical findings and complementary examinations: AP chest X-ray showing a double-contour aspect typical of a button-battery (Fig. 1).

Emergency management was standardized: emergency extraction under general anesthesia, using a hypopharyngoscope or esophagoscope and dedicated foreign body forceps. After extraction, rigid esophagoscopy screened for esophageal lesions and complications. In case of large lesions contraindicating rigid esophagoscopy of the lower esophagus, the duty pediatric gastroenterologist was called in to perform flexible endoscopy with minimal or no insufflation.

In case of mucosal esophageal lesion (necrosis-ulceration, inflammation, bleeding, granuloma), a nasogastric feeding tube adapted to the patient's size was fitted under visual control, with exclusive tube feeding for 1 week.

In case of large esophageal lesions and/or associated laryngeal lesion and/or fever, postoperative surveillance could be conducted in the surgical intensive care unit; otherwise, admission was to the ENT department. Surveillance of temperature, neck or chest pain and subcutaneous emphysema continued throughout hospital stay.

After 1 week's surveillance, endoscopy under general anesthesia was repeated to check lesion healing. If healing was complete or nearly complete, the nasogastric tube was removed and oral feeding was authorized. If healing was insufficient, the tube was maintained for 3 more weeks, and home care was ensured after discharge so as to continue enteral feeding.

Hospital costs were calculated, in agreement with the Medical Information Department, on the basis of a daily price of €1710.24 for ENT stay in 2016, €4447.12 for intensive care, both including endoscopy (<http://hopital-necker.aphp.fr/wp-content/blogs.dir/13/files/2012/03/TARIFS-FS-2013-version-du-28-05-2013.pdf>), and €173 for home care.

Data were analyzed by Student test on BiostaTGV software (<http://www.marne.u707.jussieu.fr/>).

### 3. Results

Twenty-six patients were included (Table 1): 22 boys (84.6%) and 4 girls (15.4%) (M/F sex ratio: 5.3); median age, 25 months (range, 13–62 months). Notable history included 1 case of Down

syndrome (case No. 15) and 1 of sickle-cell anemia (case No. 18). Median impaction time was 17.3 hours (range, 2–72 hours). Battery origin was known in 23/26 cases: remote control (mainly for internet box or television) without screw-secured battery compartment in 11 cases (42.30%), open pack of new batteries in 4 (15.4%), children's toy in 4 (15.4%), camera in 2 (7.7%), hearing aid without screw-secured battery compartment in 2, and watch in 1. Twenty-five of the 26 batteries had diameter  $\geq 20$  mm. Fig. 2 shows the number of cases per year.

Initial clinical signs at ingestion comprised vomiting (10 cases, 38.46%), fever (7 cases, 26.92%), hypersialorrhea (7 cases, 26.92%) and, less frequently, chest pain, dysphagia, cough or dysphonia (Table 1). Signs could be associated; 2 patients were asymptomatic.

Lesions were mainly located in the superior third of the esophagus (16 cases, 61.5%), circular (12 cases, 46.2%) and ulcero-necrotic (80.8%). Table 1 shows lesion locations, topographies and types.

All 25 patients who had systematic second endoscopy at a median 7 days still showed lesions. One (case No. 23) did not have day-7 endoscopy, as the lesions seemed very superficial on the first endoscopy, with only 2 hours impaction time; oral feeding was resumed on day 7, after removal of the nasogastric tube. Two patients (cases Nos. 6 and 8) resumed oral feeding after the control endoscopy. The tube was reinserted in the other 23 patients. Mean enteral feeding time was 35.26 days (range, 7–150 days; standard deviation, 26.4). Between 1 and 5 endoscopies were performed (median, 3).

Seven patients (26.92%) developed 6 different complications, sometimes associated: 2 cases of pneumomediastinum, 2 of inhalation pneumopathy, 2 of stenosis of the superior third of the esophagus, 1 of mediastinitis, 1 of vocal-fold palsy, and 1 of tracheoesophageal fistula.

Impaction time was  $\geq 2$  hours in all cases; it was significantly longer in the subgroup with complications [cases Nos. 5, 7, 8, 12, 15, 23 and 25: 39.7 versus 9.1 hours ( $P=0.038$ )], and hospital stay was longer (35.6 versus 11 days without home care, and 60.4 versus 27 days with), although the difference was not significant.

### 4. Discussion

The present study reports 26 cases of esophageal impaction of a button-battery in a 7-year period in the pediatric ENT emergency department serving the Paris region of France. The incidence reported by Litovitz et al. in 2010 [6] was 10.7 battery ingestions per million, including 2.65% with esophageal impaction. Between 1985 and 2009 the US Poison Center (<http://www.poison.org/>) reported annual incidence of button-battery ingestion ranging from 6.3 to 15.1 per million, with 11.1/m in 2009 [7]. Total incidence did not increase over the period but, over the same period, the rate of major or fatal complications rose 6.7-fold [8], perhaps due to increased use of flat batteries exceeding 20 mm in diameter. In the present study, the upward trend appeared in 2012 (Fig. 1). The incidence reported in our series cannot be compared to other reports, as the pediatric management of this pathology in the Île-de-France region involves a number of other hospital centers as well as Necker.

Data from the poison center of Lille (France) for battery ingestion regardless of location (1427 cases), in contrast, showed a constant increase in the number of cases from 2001 (88 cases) to 2010 (171 cases) (see Lille Poison Center magazine: <http://cap.chru-lille.fr/GP/magazines/102612.html>).

The spread of home multimedia devices entails a double risk: an increase in the incidence of button-battery ingestion, and increasing use of larger batteries, with life-threatening consequences in case of esophageal impaction in children [9].

The clinical profile of the present series agrees with the literature: male predominance (84.6%, slightly higher than in other reports, where it ranged between 58.7% [10] and 75% [4]), very

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