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CASE REPORT

Evaluation of A Case of Battery Ingestion with Inductively Coupled Plasma-Mass Spectrometry Metal Analysis

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ABSTRACT

Accidents related to swallowing foreign bodies in small children are common. With technological developments the number of battery-powered tools and toys has increased. Produced in various sizes, especially in the form of buttons, batteries can pose as a danger to children. Heavy metals such as mercury, silver, manganese, zinc, lead, cadmium, nickel, and lithium can be found in batteries. As reported in various studies cases of poisoning caused by the ingestion of batteries has increased in the last 20 years and comprises 2% of all cases related to swallowing a foreign body.
In this report a 10-month-old infant who died as a result of complications of battery swallowing was evaluated with postmortem examination, to aid in the investigation of the cause of death. Besides the general toxicological analysis and pathological findings inductively coupled plasma-mass spectrometry (ICP/MS) metal analysis results were evaluated for the first time in a case involving battery ingestion.

Key words: Battery ingestion, foreign body swallowing, ICP/MS, metal analysis

Introduction

Ingestion of alkaline batteries especially by infants and young children in the form of a disc or button is an event that can occur easily and is often unnoticed by parents. With the developments in technology battery ingestion cases are almost at the top of the list of intoxication cases (1).

Children that ingest batteries are more commonly taken to a hospital after they become symptomatic. A significant number of these cases are assessed as an upper or lower respiratory tract infection and are sent home with a prescription of antibiotics and symptomatic treatment, consequently leading to a delay in diagnosis and serious side effects (2). Ingested batteries may become immobile especially in the narrow zones of the esophagus, which may lead to tissue necrosis by hydrolysis. In most children that have ingested a battery, typical symptoms are not seen. The most common symptoms are dysphagia, fever, respiratory distress, restlessness, and salivation. However, electrolyte leakage, pressure necrosis, metal toxicity or damage by creating an alkaline environment may occur. Severe esophageal damage (perforation, burns, adhesion, etc.), mediastinitis, and tracheoesophageal fistula may also occur (2). Case reports described deaths of two children that died as a result of esophageal burns after direct interaction with a battery and six children with esophageal perforation and four with tracheoesophageal fistulas (3).

In postmortem cases of battery ingestions metal analysis from toxicology laboratories are uncommon. In this article we present a case where inductively coupled plasma-mass spectrometry (ICP/MS) metal analysis was used for the first time in the postmortem analysis of a case of battery ingestion.

Case

A 10-month-old infant became ill after ingesting a battery. He was treated in various hospitals and died after 12 days due to complications. The child's corpse was sent to the Ankara branch of the Forensic Medicine Institution for an autopsy.

According to the hospital records that were evaluated retrospectively the infant was taken to the hospital by his parents on the day he became ill. He was diagnosed with bronchitis and was discharged after the initiation of antibiotics. The patient's complaints continued with additional vomiting for 3 days and he was taken to another hospital where both posterior-anterior and lateral chest X-rays were taken and an opacity compatible with a foreign object was detected. He additionally had tonsillar hypertrophy and hyperemia. He was hospitalized and a tablet battery was removed endoscopically from the esophagus. The data about the type and size of the battery was not indicated in the files. The patient was followed postoperatively for 5 days and when his complaints resolved he was discharged. Esophagus-stomach-duodenum (ESD) radiographs were planned for 3 weeks later. Four days after being discharged he was returned to the hospital with a complaint of bloody vomiting. He was hospitalized again with the diagnosis of esophageal burns. Posterior-antarior and abdomen X-rays were nonspecific and the hemoglobin (Hb) value was 8.3 g/dL. Oral intake was prohibited and intravenous fluids were started. Multiple antibiotics (Duocid®, Amica®, Cleocin®) and a cool-mist humidifier was applied. During management hematemesis started and melena was determined by rectal examination and the Hb decreased to 5.4 g/dL. The patient's condition continued to deteriorate and he was intubated. Erythrocyte suspension was given. The patient went into cardiopulmonary arrest and cardio pulmonary resusitation was applied for 60 min. Despite all efforts the infant deceased.

Postmortem findings

Congestion was observed in the histopathological examination of the brain, brain stem, cerebellum, lungs, kidneys, spleen, heart, liver, thymus, and intestines. Fresh bleeding areas were detected in the lungs and thymus. Loss of esophageal squamous epithelial cells, necro-inflammatory reaction reaching to full-thickness of the tracheal cartilage wall and submucosal areas, fresh hemorrhage, and fibrovascular proliferation was observed. Additionally, adjacent inflammatory infiltration and bleeding in the vessel wall were noticed (Figures 1-3). These findings were evaluated as tracheo-esophageal fistula.

Toxicological investigation: No significant evidence was obtained after evaluating the contents of the stomach and bladder washing fluid (BWF) according to the systematic toxic search list. Methamizol and esomeprazole were detected in the blood sample. Element analysis was performed on blood and bladder washing fluid. Lead (Pb), zinc

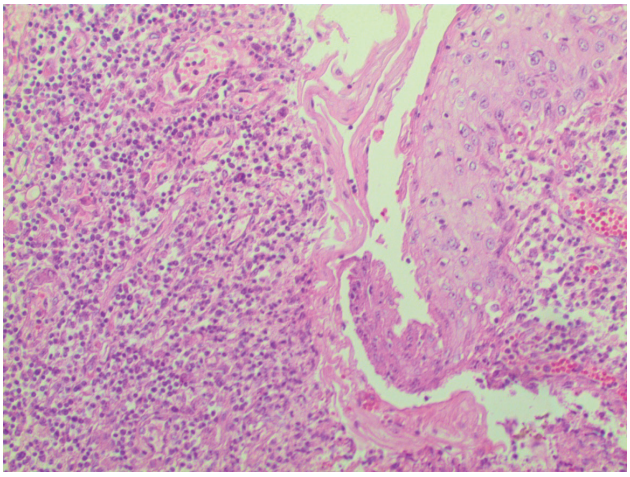

Figure 1. Loss of esophageal squamous epithelial cells and acute necro-inflammatory reaction (HE X 200)

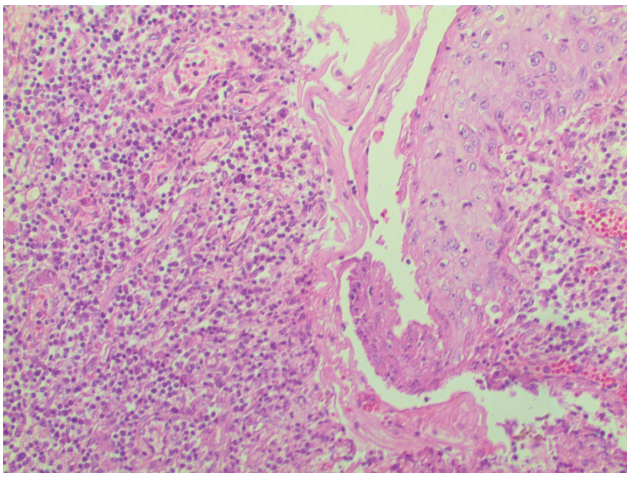

Figure 2. Inflammatory infiltration in tracheal cartilage and submucosal areas (HE X 100)

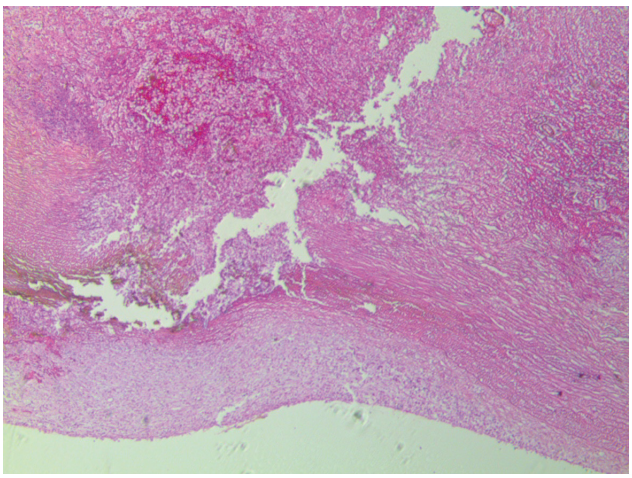

Figure 3. Inflammatory infiltration in the vessel wall (HE X 50)

Table 1. The distribution of total cholesterol, triglyceride (TG), high-density lipoprotein (HDL) and low-density lipoprotein (LDL) levels as mean ±SD according to gender

Element	Blood- sample (µg/mL)	Blood- normal* (µg/mL)	Blood-toxic* (µg/mL)	BWF (µg/mL)	Stomach content (µg/mL)
Lead (Pb)	3.7	–0.16 (–0.3)	0.4–0.6	3.06	3.89
Zinc (Zn)	2.3	0.6 –1.3	2	0.65	1.94
Nickel (Ni)	0.03	–0.003	0.005	0.05	0.034
Cadmium (Cd)	0.13	–0.0065	0.015–0.05	0.13	0.084
Lithium (Li)	4	4–8	13	0.004	0.002
Mercury (Hg)	0.016	<0.005	0.05–0.2	0.016	0.018

*Pharmazie 58 (2003), adult level

(Zn), nickel (Ni) and cadmium (Cd) levels were increased whereas lithium (Li) and mercury (Hg) levels were normal. The results of element levels were provided in Table 1.

Table 1. Element levels of blood, BWF (bladder washing fluid) and stomach content

Discussion

In this case the child was diagnosed with a simple infectious disease on his first admission to the hospital and battery ingestion was not noticed. However, in cases of battery ingestion it is very important to intervene in the first 2–2.5 hours to prevent permanent damages (4). Otherwise, even if the battery is removed, it can lead to permanent damage or cause fatal conditions due to residual alkaline environment and toxic effect.

The delay of early diagnosis and treatment, as noticed above, caused the development of esophageal burns and the patient died. According to the postmortem autopsy and toxicological examinations the cause of death was the complications of battery ingestion (esophageal burns, esophageal fistula, and gastrointestinal bleeding).

According to the literature severe damage or death is more frequently in children under 4 years of age. In 27% of the total cases and 54% of the deaths, clinicians missed the diagnosis of a battery lodged in the esophagus. 92% of those who died, 56% of the total cases were undiagnosed battery ingestions. However patients apply to the hospital with other complaints rather than battery ingestion. Battery diameter and chemistry are initially unknown in more than 40% of cases (4).

Small disc-shaped batteries are used in watches, calculators, cameras and toys. These batteries are one of the most common causes of caustic esophageal injury in infants and children. Batteries smaller than 15 mm do not stay in the esophagus. It is very probable that batteries larger than 20 mm will get stuck in the esophagus (1). 90% of cases are diagnosed by radiography. The basic principle of treatment is the primary repair within 24 hours. The best results in esophageal perforation are provided by primary repair in the early period, and by esophagectomy and gastric reconstruction in the late period (5,6).

Element analysis was used for the first time in such a case, as part of the postmortem examination in order to determine the cause of death. Besides local damage caused by the battery, toxic effects may also occur depending on the metals. According to the literature, in cases of battery ingestion local damage is more commonly detected than heavy metal toxicity (7).

In our case, samples (blood, bladder washing fluid and stomach contents) obtained from the autopsy were prepared according to the appropriate method and analyzed with ICP/MS for elements possibly found in batteries. The obtained values confirmed battery ingestion with the increased levels of Pb (lead), Zn (zinc), Ni (nickel) and Cd (cadmium). The level of Li (lithium) was normal and Hg (mercury) was nearly at a toxic level. Reference values for adults were used for comparing the results. These values might be more toxic in young children. Furthermore there are no reference values for postmortem samples of heavy metals associated with battery ingestion. According to these results delay of diagnosis and treatment resulted with the corrosion of the battery, local corrosive damage and possible systemic heavy metal toxicity. Foreign body aspiration especially of the battery should be considered in the differencial diagnosis of infants and children brought

to hospital with complaints such as fever, vomiting, cough, respiratory distress, irritability, and feeding problems. Even if the battery is removed it should be kept in mind that locally invasive damage and further systemic toxicity may continue for several weeks.

It is hard to say that metal toxicity is the cause of death in this case because there is strong evidences of esophageal burns and an esophageal fistula in the autopsy findings. But in deaths due to complications of battery ingestion metal analysis should be added to general postmortem investigations in order to reveal the concentration of metals in blood and the possible effect of metals as a cause of death especially in delayed diagnosis.

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