

## Clinical Analysis of Disc Battery Ingestion in Children

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**Background:** The purpose of this study was to evaluate the characteristics, management, and outcomes of disc battery ingestion in children.

**Methods:** We reviewed the medical records of children aged between 1 and 15 years old admitted to Chang Gung Children's Hospital due to disc battery ingestion from September 1997 through July 2003). The diagnosis of disc battery ingestion was based upon history, clinical symptoms, and results of imaging studies. The clinical data reviewed included sex, age, clinical manifestation, hospital course, imaging findings, and endoscopic results.

**Results:** We found 12 cases (8 males and 4 females) of disc battery ingestion with a mean age of  $1.8 \pm 3.43$  years (range, 9 months to 5 years). Two patients had symptoms of vomiting, nausea, and abdominal pain. Two cases with no history of disc battery ingestion and were accidentally found by X ray studies. Four cases had their batteries impacted in the esophagus and eight cases had their batteries impacted in stomach. In those patients with esophageal impaction, one died suddenly, and the batteries were removed successfully by endoscope in the other three. Among those patients with batteries in the stomach, two patients underwent endoscope removal and the other 6 patients experienced smooth courses and the batteries spontaneously passed through the gastrointestinal tract within 5 days. The diameter of the ingested disc batteries ranged from 12 mm to 23 mm. The duration of hospitalization varied from 1 day to 61 days. Four patients had obvious damage of gastrointestinal mucosa including three esophageal mucosal erosion lesions, and one gastric mucosa erosion lesions with hemorrhage. Two patients experienced complications: one died suddenly due to tension in the pneumothorax and pneumoperitoneum and the other had tracheoesophageal fistula.

**Conclusions:** Most cases of disc battery ingestion run uneventful courses. However, the ingestion of some disc batteries may be fatal or complicated with life-threatening events. If the battery impacts in the esophagus, emergency endoscopic management is necessary. Once in the stomach, the battery will usually pass through the gastrointestinal tract without long-term complications.

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**Key words:** disc battery ingestion, children.

Button batteries are those small, coin-shaped batteries used in watches, calculators, hearing aids,

and other similar appliances. The incidence of ingestion of button batteries has increased during the past

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several years as the availability of these devices has increased.<sup>(1)</sup>

Before 1983, there were only 6 cases of button battery ingestion in the medical literature.<sup>(2)</sup> In the earliest reports in the literature, either serious sequel developed or were feared. Now there are frequent reports, some with retrospective analyses as in the report by Litovitz of 119 cases which is the largest study reported in the world to date.

Recommendations for management ranged from past aggressive treatment including surgery to now successful conservative management.<sup>(3)</sup> We herein report our experience of disc battery ingestion in children focusing on clinical characteristics, management, and outcomes. In addition, we included clinical observations of endoscope findings and long term complications.

## METHODS

We reviewed the medical records of children admitted to Chang Gung Children's Hospital due to disc battery ingestion from September 1997 through July 2003. The Chang Gung Children's Hospital has 462 licensed beds where specialized teams of health care professionals provide care to critically ill infants, children, and adolescents with a 2 million patient population size per year. The diagnosis of disc battery ingestion was based on history, clinical symptoms, and results of imaging studies. The clinical data reviewed included gender, age, clinical manifestation, hospital course, imaging findings, and endoscope results.

## RESULTS

Twelve patients were enrolled in this study (Table 1). There were 8 male patients and 4 female patients. The ages of the patients ranged from 9 months to 5 years old with a mean age of  $1.82 \pm 1.36$  years. The most common symptoms included

abdominal pain (16%), and cough (16%), and followed by vomiting (8%). The mean duration of ingestion was  $5.11 \pm 4.31$  hours (range, 1 to 16 hours). Among the 12 patients, 2 patients (16%) had no history of disc battery ingestion and were incidentally found during radiological examination. Both of them presented with intractable cough and poor appetite for 2 days, and one of them was dead on arrival at our emergency department. The diameters of disc batteries varied from 12 mm to 23 mm (mean,  $17.2 \pm 4.5$  mm).

Each patient underwent plain radiological examination and 5 patients received endoscopic studies. Four cases (33%) had esophageal battery impaction and eight cases (67%) had gastric impaction. The mean ages of those patients with esophageal and gastric disc battery impaction were  $2.17 \pm 1.91$  years and  $1.77 \pm 1.04$  years, respectively. The locations of disc batteries in the esophagus was mostly found in the upper third (75%), followed by esophagocardic junctions (25%). Figure 1 demonstrates an ingested disc battery in the upper part of the esophagus in a patient. The mean diameter of disc battery located in



**Fig. 1** Chest X-ray demonstrating an ingested disc battery in the upper esophagus of a patient.

**Table 1.** Clinical Course, Outcomes and Complications

|           | Case | Endoscope examination | Successful removal | Death | Fistula damage | Mucosa passage | Smooth |
|-----------|------|-----------------------|--------------------|-------|----------------|----------------|--------|
| Esophagus | 4    | 3                     | 3                  | 1     | 1              | 3              | 0      |
| Stomach   | 8    | 2                     | 1                  | 0     | 0              | 1              | 7      |

esophagus and stomach was  $21.2 \pm 1.5$  and  $15.2 \pm 4.2$ , mm, respectively. The diameter of 75% of the impacted esophageal disc batteries measured greater than 2 cm in diameter, but only 25% of gastric disc batteries measured greater than 2 cm in diameter.

The duration of hospitalization ranged from 1 day to 61 days (mean,  $8.09 \pm 17.76$  days). The duration the batteries were lodged in stomach ranged from 1 day to 4 days (mean,  $1.62 \pm 1.06$  days), and those in the esophagus were lodged for 5 days to 61 days (mean,  $25.33 \pm 30.98$  days). One patient died suddenly in our emergency department. Three patients with esophageal foreign bodies had their batteries removed successfully by endoscope within hours after admission. One of them developed a tracheoesophageal fistula. This patient received broad spectrum antibiotics and nasogastric tube feeding, but still had severe complications during the 61-day hospital stay. Two patients (12%) underwent endoscope removal of gastric batteries and the other 6 patients the batteries spontaneously passed through the gastrointestinal tract within 5 days. Figure 2 shows a battery with corrosive dissolution in a child with gastric disc battery ingestion removed using endoscopy. A total of 5 patients (41.6%) had obvious gastrointestinal damage by clinical and endoscopic evaluation. Four patients had endoscopic mucosal damage including three with esophageal mucosal erosion (one finally developed tracheoesophageal fistula), and one with gastric mucosal erosion with



**Fig. 2** A battery removed by endoscope (right) with corrosive dissolution in a child with gastric disc battery ingestion, compared with a normal battery (left).

hemorrhage. One patient died suddenly and was clinically suggested to have esophageal perforation complicated with tension pneumothorax and pneumoperitoneum. Among the patients with endoscopic removal of disc battery in the esophagus, all of them pathologically revealed mucosa erosion with necrosis.

In eight patients with gastric battery discs, 2 cases underwent endoscopic examination. One had mucosa hemorrhage and erosions over the gastric body, the other one had a retained battery in the stomach for 2 days without symptoms or damage of the gastric mucosa. The patient defecated the disc battery on the 5th day after ingestion. The remaining six patients who did not undergo endoscopic examinations underwent close observation and supportive care during hospitalization. Five of them (83%) had their batteries pass through their gastrointestinal tracts within 48 hours. The diameters of these defected batteries were smaller than 2 cm.

## DISCUSSION

Button batteries contain mercury, silver, zinc, manganese, cadmium, lithium, sulfur oxide, copper, brass, or steel as the components of the anode, cathode.<sup>(4,5)</sup> They also contain either sodium hydroxide or potassium hydroxide to facilitate the electrochemical reactions through the electrolyte-soaked separation.<sup>(6)</sup> The three most commonly involved battery systems are those with manganese dioxide, silver oxide, and mercuric oxide.<sup>(7)</sup> These three systems contain alkaline electrolytes that are usually 26% to 45% potassium hydroxide or sodium hydroxide.<sup>(8)</sup> The alkaline solution is strong enough to cause rapid liquefaction necrosis of tissue.<sup>(9,10)</sup> In cases of battery ingestion, the mechanism of injury occurs by three different means including direct corrosive action, low voltage burns, and pressure necrosis.<sup>(11)</sup> Liquefaction necrosis and perforation can occur as soon as 4 to 6 hours after a disk battery is lodged in the esophagus.<sup>(7,12,13)</sup>

According to previous reports, the ingestion of button batteries usually occurs in children. The sizes of button batteries vary in diameter from 7.9 to 23 mm and in weight from 1 to 10 grams.<sup>(14)</sup> Button battery ingestion usually causes problems in children if the diameter of battery greater than 20 mm.<sup>(1)</sup> Hearing aid batteries and mercuric oxide batteries are the two most commonly ingested according to

previous observation.<sup>(5)</sup> A previous report stated that children less than 5 years of age are the most common victims.<sup>(15)</sup> Button batteries lodged in the esophagus is a true emergency and the batteries should be immediately removed because of the possible fatal complications due to rapid action of the alkaline substance on the mucosa and the pressure necrosis.<sup>(16)</sup> Once lodged in the stomach, most disk batteries pass through uneventfully. Some authors have indicated that 85% of such button batteries are passed within 72 hours.<sup>(15)</sup> The benefits of H2 blockers or laxatives have not been confirmed for those patients with disc batteries in the gastrointestinal tract.<sup>(17)</sup> Surgery is indicated only if the patient develops signs of perforation or obstruction of the bowel.<sup>(18-20)</sup>

All of our patients were less than 5 years old and most patients (50%) were between 1 and 2 years old and male gender was predominant (67%). Most children (84%) were asymptomatic after disc battery ingestion. Radiography is a reliable method for establishing the location of the ingested button. In our cases, we found that those who ingested disc batteries with diameters larger than 2 cm were at risk for gastrointestinal mucosa damage because such batteries easily impacted in the esophagus (60%), or took more time to pass through the gastrointestinal tract. In our observation, when disc batteries were lodged in the esophagus, damage to the esophagus mucosa may occur within 5 hours, thus generating more severe gastrointestinal damage such as mucosal erosion, fistula formation, or sudden death due to tension pneumothorax.

Most cases of disc battery ingestion run uneventful courses and are usually benign. Severe complications are usually caused by large button batteries lodged in esophagus. Such batteries may cause necrosis or perforation of esophagus which leads to tracheoesophageal fistula, mediastinitis, pneumothorax, and even sepsis or shock with time.<sup>(7)</sup> Emergent endoscopic management and close follow up of the clinical course are necessary when the disc battery is impacted in esophagus. Once lodged in the stomach, the battery will usually pass through the gastrointestinal tract without difficulty. Prevention plays an important role in button battery ingestion. We recommend that the batteries should be kept in a safe place where children are unable to reach them.

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# 兒童誤食鈕扣電池的臨床分析

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**背景：** 評估兒童誤食鈕扣電池的臨床特性，預後和處理。

**方法：** 我們回溯分析重 1997年9月到2003年7月這5年間因為誤食鈕扣電池而住到兒童醫院的小兒科病患。誤食電池的診斷是基於病史、症狀和影像學檢查。回顧資料包括有性別、年齡、臨床表現、住院病程、影像學發現和內視鏡結果。

**結果：** 總計有12個病患（8男4女）因為誤食鈕扣電池住院，他們平均的年齡為 $1.8 \pm 3.43$ 歲。2位病患有吐，肚子痛等腸胃道症狀。由X光片檢查異外發現誤食電池的有2位。有4位病患吞下去的電池卡在食道，另外有8位掉到胃。1位病患因電池卡在食道併發壓力性氣胸而猝死，另外3個則成功的經由內視鏡移除。電池掉到胃的有2位接受內視鏡檢查，其他6位病患則在5天內解出電池。所有電池的直徑從12mm到23mm。這12位病童的住院病程為1天至61天。4位病患經由內視鏡檢查發現有明顯黏膜受傷包括3位食道黏膜糜爛和1位胃出血。有2位病童產生嚴重後遺症，其中1位猝死，另外1位則併發氣管食道瘻管。

**結論：** 大部份誤食鈕扣電池的病患不會有嚴重的問題。但是有些也會有致命的危險。如果電池卡在食道，經由內視鏡緊急處理是必要的。一旦掉入胃部，大部份會自然排出而不會有長期併發症。

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**關鍵字：** 誤食鈕扣電池，兒童。