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Endoscopic Findings and Correlation with Outcome in Oesophagal Battery Button Ingestion in Children

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ABSTRACT

***Objective*:** To determine the endoscopic findings and its correlation with outcome in oesophageal battery button ingestion in children.

Study Design: Cross sectional study.

Place and Duration of study: Department of Paediatric Gastroenterology, Hepatology, Children's Hospital and University of Child Health Sciences, Lahore Pakistan, from Jul 2021 to Jun 2022.

***Methodology*:** We recruited children with button battery ingestion over a period of one year. Data of the patients' demographics, symptoms, time from ingestion to admission, oesophagal location and size of the battery, grade of mucosal injury, management, complications, and follow-up outcome were recorded.

***Results*:** Forty-one children with a mean age of 3.6±1.76 years (range: 1-9 years) were enrolled over one year. The most common site of battery impaction was the lower end of the oesophagus 22 (53.7%). The median time from ingestion to admission was 7.2 hours, with vomiting and chest pain being the most common admission symptoms noted in 24 (58.5%) cases. According to Zargar's classification, Grade II mucosal injury was most frequent in 21 (51.2%) patients, followed by Grade III in 11 (26.8%) children, and 9 (22%) cases developed oesophagal strictures later on. Regarding the size of the battery, we could measure the diameter, and the median was 18.0 mm (range, 18–20 mm). Three patients had severe complications other than strictures, in one case each (2.4%), and these children could not survive and died due to complications of fistulas and massive bleeding.

***Conclusion*:** Button-battery ingestion is a frequently noticed problem in developing countries like Pakistan. Immediate recognition and endoscopic removal are necessary for oesophagal battery button ingestion to avoid long-term morbidity.

Keywords: Tracheoesophageal fistula; Esophageal perforations; Esophageal-aortal fistulas.

How to Cite This Article: *Khoso MS, Saeed A, Anjum MN, Fayyaz Z, Alvi MA, Kokab H, Rehman H, Cheema HA. Endoscopic Findings and Correlation with Outcome in Oesophagal Battery Button Ingestion in Children. Pak Armed Forces Med J 2024; 74(2): 549-554.*

DOI: https://doi.org/10.51253/pafmj.v74i2.9601

INTRODUCTION

Foreign body ingestion is quite often seen in paediatric emergency departments all over the globe. It is estimated that 80% of all foreign body ingestion happens in children from 6 months to 6 years of age.[1,2] Among these foreign bodies, the most frequent include a variety of play toys, coins, and different types of button batteries.[3] Button-battery ingestion requires emergency diagnosis and emergency extraction.[4] The prevalence of button battery ingestion is dramatically on the rise due to (i) the increased number of toys (and other kinds of devices, e.g., watches) using battery cells, (ii) the battery which could be attractive for young children because of their shape and colour as they may get confused with other food objects, like candies. [5]

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Received: 27 Nov2022; revision received: 02 Dec 2022; accepted: 12 Dec 2022

Button battery cells having various sizes, if less than 18 mm in diameter, usually pass from the oesophagus easily without creating any problem and rarely need removal beyond the oesophagus.[6] If their diameter is between 18-mm and 25-mm, button batteries mostly impact the oesophagus, which needs emergency removal.[7] These button batteries contain silver oxide, manganese dioxide, mercuric oxide, zinc, or lithium in different electronic gadgets. In comparison with other batteries, lithium-containing batteries have the strongest current that is associated with high morbidity and mortality.[8,9] The range of injury caused by battery button ingestion is from mild erythema of oesophagal mucosa to deep, extensive ulcerations that lead to tracheoesophageal or aorto-oesophagal fistulas and oesophagal perforation. Patients may develop complications despite battery removal because of its advanced electrochemical charge.[10]

The primary aim of our study was to define the endoscopic findings in children with button battery

ingestion. The secondary objective was to highlight the frequency of button battery ingestion among the foreign bodies in the specified study period and the clinical features, complications, and outcomes following button battery ingestion in the Children's Hospital and University of Child Health Sciences, Lahore.

METHODOLOGY

The cross sectional study was conducted at the Department of Paediatric Gastroenterology, Hepatology, Children's Hospital and University of Child Health Sciences, Lahore Pakistan, from July 2021 to June 2022. After approval by the IRB.

Inclusion Criteria: Patients of either gender and aged below 16 years with suspected or known button battery ingestion were included.

Exclusion Criteria: Patients with ingestion of foreign bodies other than button batteries were excluded.

Patients were enrolled in the study after obtaining written informed consent from parents/ guardians. The diagnosis was made primarily based on the history of button battery ingestion and chest-abdomen X-ray examination. The clinical data of children with button battery ingestion were recorded in detail, including the age, gender, clinical symptoms (vomiting, chest pain, dysphagia, and coughing), duration of ingestion, button battery diameter, and location of the battery in the oesophagus, degree of mucosal injury on endoscopic examination, complications and outcome.

After confirmation of the button battery location by chest x-ray on a halo sign (Figure-1), all patients will undergo endoscopic removal of the button battery after obtaining consent from their parents. Endoscopic procedures will be performed under general anaesthesia according to international standards. The ingested button batteries were identified in the oesophagus, and their locations were recorded. Endoscopic findings were classified according to Zargar's classification, as given in Table-I.

Table-I: Zargar's Classification for Grading Injury

Grade 0	Normal Mucosa
Grade I	Edema and erythema of the mucosa
Grade IIA	Hemorrhage, erosions, blisters, superficial ulcers
Grade IIB	Circumferential lesions
Grade IIIA	Focal deep gray or brownish-black ulcers
Grade IIIB	Extensive deep gray or brownish-black ulcers
Grade IV	Perforation

Postoperatively, patients were monitored for 24 hours in the hospital for postoperative complications and symptomatic treatments, including anti-inflammatories, antacids and nutritional support, were given. All the children were followed for their complications.

Statistical Package for Social Sciences (SPSS) version 26.0 was used for the data analysis. Quantitative variables were expressed as mean±SD and qualitative variables were expressed as frequency and percentages.

RESULTS

During our study, we enrolled 41 children presented with oesophageal battery button ingestion in our hospital. There were 21(51.2%) males with a mean age of 3.6±1.76 years (Range: 1-9 years). In terms of presentation, vomiting with chest pain were the most frequent symptoms, noted in 24(58.5%) children, and three children had only chest pain with coughing, while 3(7.3%) were asymptomatic. In most cases, in 29(70.7%), the ingestion was noticed by a parent, while in 12(29.3%) cases, the ingestion was not witnessed (Table-II).

Delays in hospital presentations when seeking medical advice are an important factor that increases the risk of complications. In our study, the delay between ingestion and presentation at the hospital ranged from 2 hours to 3 months. The median time from ingestion to admission was 7.2 hours, and two cases were admitted in three months and one case in 1.5 months after battery ingestion. The median battery diameter was 18 mm (n: 22, 53.7%) and 20 mm (n: 19, 46.3%) (Range: 18–20 mm). The majority of these button batteries were impacted in the lower, middle and upper oesophagus in 22(53.7%), 15(36.6%), and 4(9.8%) cases, respectively.

The grade of oesophagal injury noted on endoscopic examination was assessed according to Zargar's classification. Most children had mucosal injuries ranging from mild to severe, and only one had a normal mucosal appearance. Grade II (n: 21, 51.2%) mucosal injury was the most frequent, followed by Grade III in 11 (26.8%) children. Twelve (29.2%) children experienced complications, which in three cases led to mortalities due to respiratory and circulatory failure. Nine (22%) cases had oesophagal strictures, while one of each case (2.4%) had a tracheoesophageal fistula, oesophagal perforations, or oesophagal-aortal fistula. Table-III shows a detailed description of complications. Three important cases are presented here.

Case-1: A 1-year-old male child presented in the emergency department with sudden onset vomiting from the last two days. Chest X-ray showed a radiopaque with a halo sign object seen at the level of T6–7. He underwent an urgent endoscopy, and an 18-mm-diameter lithium battery button was removed

Table-II: Demographic and Clinical Characteristics of Children with Button Battery Ingestion (n=41)

Characteristics	Categories	n(%)
Age (years), median (range)		3.6±1.76 years (Range: 1-9 years).
Time from ingestion to admission (h), median (range)		7.2 hours (Range: 2 hours to 3 months)
Gender, n (%)	Male	21(51.2%)
	Female	20(48.8%)
Witness situation, n (%)	Witnessed	29(70.7%)
	Not witnessed	12(29.3%)
Symptoms on admission, n (%)	Vomiting	7(17.1%)
	Chest pain	4(9.8%)
	Vomiting + Chest pain	24(58.5%)
	Chest pain + Coughing	3(7.3%)
	Asymptomatic	3(7.3%)
Location, n (%)	Proximal esophagus	4(9.8%)
	Mid esophagus	15(36.6%)
	Distal esophagus	22(53.7%)
Diameter of the battery (mm), median (range: 18–20 mm).	18 mm	22(53.7%)
	20 mm	19(46.3%)
Zargar's mucosal injury grade, n (%)	0	1(2.4%)
	I	7(17.1%)
	IIA	12(29.2%)
	IIB	9(22%)
	IIIA	2(4.8%)
	IIIB	9(22%)
	VI	1(2.4)
Complications, n (%)	Nil	29(70.7%)
	Esophageal stricture	9(22%)
	Tracheoesophageal fistula	1(2.4%)
	Esophageal perforations	1(2.4%)
	Esophageal-aortal fistulas	1(2.4%)

Table-III: Button battery ingestion with Complications (n=12)

Cases	Age	Gender	Witness	Symptom	Location	Time of ingestion to admission	Diameter of battery	Zargar's Classification	Complications	Outcome
1	1 Y	M	None	Vomiting, Chest pain,	Middle Zone	47 Hours	18 mm	Grade IIIB	Aorto-esophageal fistula	Expired
2	3 Y	F	None	Vomiting, Chest pain,	Middle Zone	3 Months	18 mm	Grade IIIB	Tracheoesophageal fistula	Expired
3	1 Y	F	None	Vomiting, Chest pain,	Upper Zone	72 Hours	18 mm	Grade IV	Esophageal Perforation	Expired
4	3 Y	M	Yes	Vomiting	Distal Zone	9 Hours	18 mm	Grade IIB	Esophageal Stricture	Dilation
5	3 Y	F	None	Vomiting, Chest pain	Middle Zone	1.5 months	18 mm	Grade IIIB	Esophageal Stricture	Dilation
6	3 Y	M	None	Chest Pain	Upper Zone	10 Hours	20 mm	Grade IIB	Esophageal Stricture	Dilation
7	5 Y	F	Yes	Vomiting, Chest pain	Middle Zone	2 Hours	20 mm	Grade IIIB	Esophageal Stricture	Dilation
8	4 Y	M	None	Vomiting, Chest pain	Upper Zone	26 Hours	20 mm	Grade IIIB	Esophageal Stricture	Dilation
9	6 Y	M	Yes	Vomiting, Chest pain	Distal Zone	2 Hours	20 mm	Grade IIIB	Esophageal Stricture	Dilation
10	4.5 Y	M	Yes	Vomiting, Chest pain	Distal Zone	2 Hours	20 mm	Grade IIIA	Esophageal Stricture	Dilation
11	3 Y	F	None	Vomiting, Chest pain	Middle Zone	3 Months	20mm	Grade IIIB	Esophageal Stricture	Dilation
12	7 Y	M	Yes	Vomiting, Chest pain	Distal Zone	2 Hours	20 mm	Grade IIIB	Esophageal Stricture	Dilation

Abbreviations: Y-yes, M-Male, F-Female

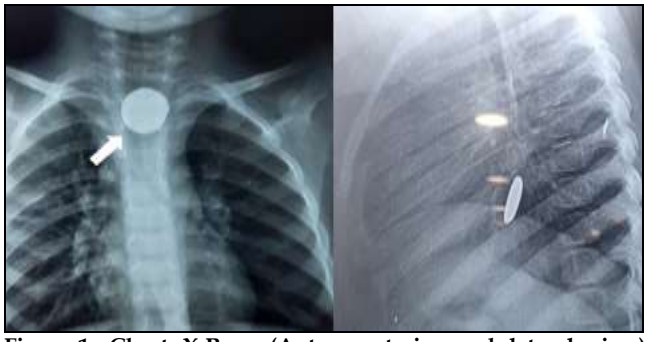

Figure-1: Chest X-Rays (Anteroposterior and lateral view), button battery impaction at different sites, and arrow showed halo sign.

successfully. Findings on endoscopy were extensive deep grey and brown-blackish ulcers of the oesophagal wall (Grade IIIB), as shown in Figure-2 (A, B, and C). The patient was discharged from the hospital in stable condition. On day 20th post-procedure, the child again presented in the emergency department with a sudden onset of vomiting containing a massive amount of blood and brought in the emergency department and suddenly developed catastrophic upper gastrointestinal bleeding and died of hypovolemic shock. Based on the clinical features and the severity of the bleeding, the suspected diagnosis was an auto-oesophagal fistula.

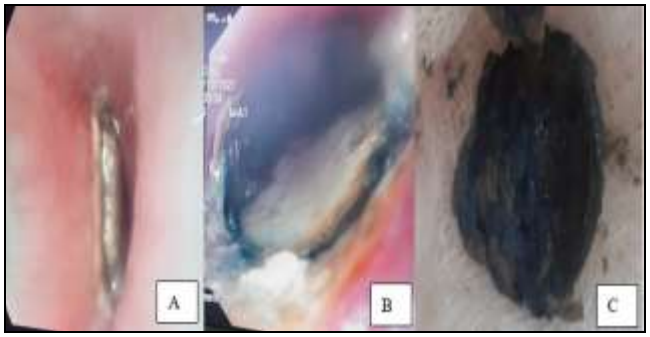

Figure-2: A & B: Endoscopy before Button Battery removal, C: Removed Button battery

Case-2: A 3-year-old girl with unwitnessed button battery ingestion and sudden onset of dysphagia with chest pain presented in the emergency department. Chest X-ray showed the button battery impacted at the middle zone; the button battery was removed, and Zargar's classification was Grade IIIB. The child developed an abnormal connection between the trachea and oesophagus. He underwent surgical correction for tracheoesophageal fistula, followed by subsequent sepsis, which expired 2 days later.

Case 3: A 1-year-old girl presented in emergency with a history of battery ingestion for three days and with sudden onset dysphagia and coughing. Chest X-ray showed the button battery impacted at the upper zone of the oesophagus; the button battery was removed, and Zargar's classification was Grade IV (Figure-3: A and B). Post-procedure, the child was shifted to MICU for further surgical intervention. Repair of oesophagal perforation was done, but she died due to mediastinitis and severe sepsis.

Figure-3: A: Chest X-ray Showed Button Battery Impacted at the Upper Zone of Esophagus.
B: Zargar's classification was Grade IV

DISCUSSION

This study showed that the percentage of oesophagal battery button ingestion is about 31.6% in all children who presented with foreign body ingestion during this one-year study period. In our study, we found a mean age of 3.6±1.76 years, and nearly half of the children (56%) are younger than three years of age. The gender distribution ratio was almost the same, which is different from other studies.[11,12]

The incidence has been increasing, as documented in a USA study (1985 to 2009), that the annual incidence of oesophageal battery cell ingestion increased from 6.3 to 15.1/1,000,000 cases, and the oesophageal impaction was about 2.65%.[13] The severity of the oesophageal injury greatly depends upon the electrical charge of the battery, as injury to the oesophagus happens within 0.5-2 hours of button battery ingestion.[14] However, in our study, 21 patients presented in the emergency department within 2 hours of ingestion and six developed grade 3 mucosal injury, supposing those batteries were fully charged. The incidence of major and fatal complications has increased to 6.7% because of the increased use of high-voltage lithium batteries exceeding the diameter of 20 mm, leading to more serious damage to the

oesophagal wall with impaction.15 In the present study, most batteries were between 18-20 mm in diameter, commonly used in playing gadgets.

Our study showed the same results; the major symptom was vomiting (17.1%), followed by chest pain (9.8%), while 7.3% of patients were asymptomatic. Additionally, we analyzed symptoms together, demonstrating that vomiting with chest pain was the most frequent symptom, as noted in (58.5%) cases and (7.3%) of cases with chest pain with coughing. Proper histories from parents/ guardians or potential witnesses majorly identify a foreign body.[16] In our study, children presented in the emergency department early to seek medical attention, those who had known battery cell ingestion than unwitnessed children and about 17% of children developed serious complications requiring invasive procedures like balloon dilations, and few patients died due to various complications.

We had three children with impaction in the upper zone, and serious complications leading to mortalities include aorto-oesophagal fistula and perforation, and the rest of them developed oesophagal stricture requiring endoscopic dilation. In the present study, there were 12(29%) children developed complications, 22% had oesophagal strictures, 7.3% had fistulas or perforations and died of various complications.

Findings on chest X-rays include a halo sign in the anterior view and a step-off sign in the lateral view. [17] In this study, all children underwent the standard radiologic workup with immediate neck, chest, and abdominal plain X-ray films in anteroposterior and lateral views, as shown in the X-ray pictures in the result section.

The endoscopic examination in our study was performed in children within 2-hours of arrival in the hospital. In the current study, all patients underwent endoscopic examination, and most button batteries were removed, whether in the oesophagus or the stomach. Zargar's classification for caustic injury grading has been in practice for more than a decade to guide plans. [18] In our study, the grading of oesophagal injury was recorded according to Zargar's classification. Grading of oesophagal injury has a direct role in the clinical outcome. In our study, no child with grade 0 or I mucosal injury developed complications, but dilatation was required in 2/21 cases with grade II injury and 7/11 cases with grade III injury. At the same time, two with grade III injuries developed fistulas (tracheoesophageal and oesophagal-aortal). Therefore, our findings demonstrate that the clinical outcome after endoscopic removal of a battery largely depends upon the grading of injury, with higher-grade injury, particularly grade III injury, most likely needing oesophagal dilation. We found that the patients admitted to the hospital early, within 2-5 hours, developed grade 0-I mucosal injury, 3-8 hours with grade IIA-IIB, while those who presented late (range, 6–>72 hrs) developed grade IIIA-IIIB mucosal injury.

We kept all our children on close follow-up to see the outcome and early detection of complications. The nothing per oral or feeding should be carefully assessed according to disease severity and complications. Gastrointestinal decompression and intravenous proton pump inhibitors (PPI) can help heal the injury by preventing the backflow of stomach content to the oesophagus.[19] Prevention is the best modality. Parents and guardians should know the possible danger of battery cell ingestion and its immediate management. Precautions shall be taken to secure the devices containing button batteries from the reach of young children. Product constructors must remodel battery-contained household materials to ensure the chambers for holding a battery.[20]

We hope to raise awareness of the life-threatening complications in children with oesophagal battery button ingestion and inspire the incorporation of the course of action after button battery ingestion into national guideliness.

LIMITATION OF STUDY

Community awareness programs using electronic and print media, while pamphlets should be dispersed to the public to educate and enhance parental knowledge regarding dangerous materials. Parents and guardians should know about choking-related rescue manoeuvres.

CONCLUSION

The present study showed that button battery is a common emergency in developing countries like Pakistan, requiring urgent endoscopic intervention. Children presented with accidental ingestion of battery buttons can be presented with lethal complications. Diagnosis is usually a delay in unnoticed witness, unusual clinical manifestations, long exposure to oesophagal mucosa, and electric charge and size of button battery had a major effect on the outcome. Immediate endoscopic removal is the treatment of choice. Close follow-up is mandatory to monitor for long-term complications.

Conflict of Interest: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

MSK & AS: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

MNA & ZF: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MAA & HK & HR & HAC: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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