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Battery-induced Esophageal Foreign Body Injury, Complications and Treatment Outcome

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ABSTRACT

Objective: We aimed to assess the severity caused by button batteries in esophagus.

Methods: Thirty two patients admitted with ingesting button batteries were retrospectively evaluated. Chest x-ray was ordered for diagnosis. Hospital stays, interventions , complications and mortality of the patients were collected. The time between the patients ingested the buton battery and its removal was defined as its duration in esophagus. All the patients underwent rigid esophagoscopy under general anasthesia. Buton batteries at the first narrowing were removed by magyl clamp.

Results: 21 of 32 patients were female, with a mean age of 22 months. The mean duration of ingestion was 17 hours. The mean hospital stay was 10 days. Of the patients, 75% were admitted within 24 hours. Complication rate was 19% and mortality rate was 6%. There was a strong correlation among the number of the cases and the coming years ($p<0.001$). Linear regression test was used in the number of cases and the duration ($p<0.001$). It was found significant that much more cases (90%) admitted in the last 12 years compared with the number in first 12 years ($p<0.001$). There were no complication in cases in which the buton battery was impacted in esophagus for less than 24 hours, however, 8 cases whose duration was more than 24 hours resulted complicating in 6 patients and fatal in 2 patients ($p<0.001$).

Conclusion: Batteries should be removed upon its diagnosis. Otherwise, the injury to occur in the esophageal mucosa by delay can cause increase in morbidity and mortality.

Keywords: Battery, child, esophagus, perforation

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INTRODUCTION

Approximately 1500 people die annually as a result of oral foreign body exposure in the United States (1). Flat batteries (FB) account for 2% of foreign body ingestions. Batteries are associated with a high risk of esophageal perforation. The rate of battery ingestion has increased significantly in recent years with the growing popularity of battery operated toys (2,3). Flat batteries (FBs) are the second most commonly ingested objects after coins. Flat batteries are disk-shaped items with a diameter ranging from 8 to 28 mm (4). FBs may cause chemical injury in esophagus and should be immediately removed from the digestive tract within an hour (5).

SUBJECTS AND METHODS

This study retrospectively analyzed the medical data of 32 patients presenting for medical treatment after FB ingestion between 1990 and 2014 and who were diagnosed with FB lodged in the esophagus based on history, physical examination, and radiological and endoscopic examinations. Age, sex, presentation time, symptoms, findings of physical examination and radiological imaging, localization of foreign body and its time of interaction with esophagus were recorded. In addition, data pertaining to the duration of hospital stay, complications, treatment approaches, and mortality rates were collected (Table 1). All patients in the present study underwent a two-sided chest X-ray resulting in the diagnosis of foreign body (Figure 1). The time from battery ingestion to battery removal was considered equivalent to the time of battery exposure in the esophagus. All patients underwent rigid bronchoscopy under general anesthesia. Batteries lodged in the first esophageal stricture were removed with a magill forceps. FBs residing elsewhere in the esophagus were removed with esophagoscopy.

Esophagography (EG) was performed in cases of suspected esophageal perforation (Figure 2). Due to suspected perforation, iohexol (Omnipaque®) was used instead of barium in EG.

A conservative treatment approach was applied in the majority of the patients. The conservative approach included placement of a nasogastric tube into the stomach or duodenum under endoscopic guidance. The patients were fed via NG tube. The patients were followed with body temperature and laboratory monitoring, and all received antibiotics for 15 days. If vital signs were normal after 15 days a repeat EG was conducted to exclude an esophageal leak and oral intake was permitted only when no leak was observed. Treatment was continued in cases where esophageal leak was persistent.

The IBM SPSS 20.0 software package was used for all statistical analyses. The Kolmogorov Smirnov test was used to evaluate the normality of the study data; parametric tests were used for statistical analyses of normally distributed data. The Chi-square test was used to compare the number of cases by esophageal stricture point. The Pearson's correlation test was used to evaluate the correlation between age and the number of cases. In addition, the relationship between the duration of symptoms and the number of cases was analyzed by linear regression analysis. The categorical comparison between the number of cases in the first and last 12 years was evaluated using the Student's *t*-test. The correlation between the esophageal exposure time and the duration of hospital stay was analyzed using Pearson's correlation and linear regression analyses. The Chi-square test was used to compare the rates of complication and mortality between the groups with the battery staying in esophagus less than 24 hours and more than 24 hours. A p value less than 0.05 was considered statistically significant within a confidence interval of 95%.

RESULTS

All of the 32 subjects presenting with FB ingestion were children. The mean age was 22.5±22.6 months and the proportion of female patients was 65.6%. All subjects were symptomatic with difficulty in swallowing, increased salivation, and fever. The mean time from battery ingestion was 17.5 (3-72) hours. The average duration of hospital stay was 9.84 (2-62) days. Seventy-five percent of cases presented to the hospital within 24 hours after foreign body ingestion. The complication and mortality rates were 18.8% and 6.3%, respectively (Table 2).

Some patients suffered from serious complications such as esophageal perforation. Among them, one patient presented with a high fever after a 3-day delay and was diagnosed with a perforated esophagus. That patient was followed for three weeks and the perforation was sealed by control EG. The second case presented to our clinic with fever and difficulty in swallowing on the second day. The foreign body was removed from the first esophageal stricture. No esophageal perforation was noted and the patient was followed conservatively.

The third case presented after a 4-day delay. That patient had fever and difficulty in swallowing and was septic. Esophageal perforation was observed during foreign body removal and a conservative treatment was applied. The patient died as a result of sepsis. The fourth patient presented after a delay of 1 day. The FB in the second esophageal stricture was removed via esophagoscopy. An EG proved that the esophagus was perforated. The esophagus was repaired via right tracheotomy. The patient developed a fever on the second postoperative day. A control EG showed contrast material extrapolation to the left side of the thorax and the esophagus was repaired via left tracheotomy. The patient's overall status did not improve and he was lost to sepsis. A fifth case presented with a 2-day delay and complained of difficulty in swallowing and fever. A foreign body was removed from the first esophageal stricture. EG demonstrated contrast material leaking from the site of FB

localization in the proximal esophagus. A diagnosis of esophageal fistula was made. The fistula closed spontaneously after conservative treatment. The sixth patient presented to our institution 1 day after FB ingestion. The esophagus was perforated and was repaired via right thoracotomy. The patient was discharged with a full recovery thereafter. The seventh patient presented with fever and difficulty in swallowing after a 2-day delay. The FB was removed with a rigid esophagoscopy from the second stricture of the esophagus. An EG was performed, which showed thickening of the esophageal wall. A conservative treatment path was pursued and the patient was fed enterally via NG tube. An EG two weeks later showed no perforation and the patient was discharged. The eighth patient applied with difficulty in swallowing at 30 hours after FB ingestion. A FB was removed from the first esophageal stricture and a conservative treatment strategy was pursued. The patient was discharged with a full recovery after a certain time period. All surviving patients were seen on an outpatient basis following discharge and three of them were diagnosed with esophageal stenoses. All stenoses were dilated using esophagoscopy and the patients were seen at three-month intervals. Those patients developed no other complications. The patients with FB esophageal contact time of less than 8 hours were monitored for body temperature, biochemistry and complete blood count tests, and serial chest X-Ray films.

An analysis of the esophageal localization revealed that the proportion of foreign bodies detected at the first esophageal stricture (76%) was significantly greater than the number of foreign bodies located elsewhere ($p<0.001$) (Chi-square=30.06).

There was a significant correlation between the study duration in years and the number of cases ($p<0.001$, $R=0.802$) (Figure 3). A linear regression analysis of the number of cases and the study duration in years resulted in a statistically significant correlation ($p<0.001$, $R^{=}0.644$) (Table 3, Figure 4). Dichotomizing the study duration into two equal parts revealed that the percent of the cases in the first 12 years (90.7%) was significantly greater than the

number of cases diagnosed in the second 12 years (9.3%) ($p<0.001$) (Table 4). There was a strong positive correlation between the duration of foreign body exposure and the duration of the hospital stay ($p<0.001$ $R=0.718$) (Figure 5).

No complications or death occurred in the patients with esophageal battery exposure of less than 24 hours, whereas 6 of 8 cases with a duration of esophageal stay more than 24 hours had complications and the remaining two patients died ($p<0.001$).

DISCUSSION

Ingestion of foreign bodies is more common among children under 3 years of age than among older children. In patients presenting with difficulty swallowing and increased salivation, the presence of a foreign body in the esophagus should be considered. A foreign body can become lodged in the esophagus as a result of anatomic strictures and weak peristaltic movements. The clinical picture resembles that of bronchial aspiration of a foreign body, although patients may appear more comfortable in cases of esophageal foreign body ingestions, delaying diagnosis and posing a greater death risk (6-9).

The mean age of our patients was 23 months. All patients had difficulty in swallowing, increased oral secretions, and restlessness.

Esophageal FB ingestion has recently become more widespread as a result of an increase in the number of toys containing flat batteries (10). A significantly greater number of cases occurred in the last 12 years compared to the first 12 years of the study period. This may be the result of the increased availability of technology products, issues pertaining to regulation and inspection, and the lack of sociocultural knowledge regarding the safe use of products both domestically and worldwide.

Batteries may lead to necrosis and perforation as a result of mucosal pressure, electrical current, and the release of corrosive material. Batteries containing potassium and sodium may cause liquefaction necrosis. Heavy metals like mercury may result in metal poisoning in addition to necrosis and perforation. Prolonged exposure of the esophagus to batteries results in serious problems. Non-depleted FBs with a diameter of more than 15 mm exert their effects on the esophageal mucosa after 2 hours. Smaller FBs may passed to the stomach (10-12). In the present study all FBs were larger than 20 mm. Twenty-five of these FBs were lodged in the first esophageal stricture. Six FBs were found at the second esophageal stricture, although an FB passed to the stomach from the third stricture in one patient. FBs were significantly more likely to become lodged in the first stricture than in any other part of the esophagus.

FBs may be confused with coins upon radiological examination. When carefully examined, the two nested contours of FBs are often visible. When FBs are misidentified as coins and left in place, mucosal damage and esophageal perforation may result (4). Five patients experienced complications as a result of delayed diagnosis. Esophageal repair operations were conducted in two of these patients; one patient died while the other patients were discharged. No problems occurred during follow-up. Physicians working at secondary care health services must be able to distinguish FBs from coins. Early diagnosis and intervention reduce patient mortality and morbidity.

Unless removed promptly, FBs cause mucosal erosion within 1 hour and full-thickness injury within 4 hours. FBs exert corrosive effects due to the release of sodium and potassium hypochlorite (10). An animal study demonstrated that esophageal injury can occur rapidly. The researchers observed esophageal necrosis within 1 hour in dogs and within 2 to 4 hours in cats (10,13). Batteries induce burns in the esophagus, stomach, and intestines and should be removed within 24 hours (14,15). The 8 patients who were exposed to ingested FBs for longer than 24 hours had increased morbidity (duration of hospital stay) and mortality relative to the

other patients. The duration of hospital stay increased in proportion to the duration of FB exposure. More complications and increased mortality occurred among the patients who were exposed to FBs for more than 24 hours. FBs should be removed within 24 hours to reduce morbidity and mortality.

Perforation repair should be performed within 24 hours. Early repair of perforation injuries can help to reduce complications. When FB exposure time is greater that 24 hours, the treatment strategy should assume the presence of esophageal injury. In case of a severe esophageal burn it is advisable to avoid feeding the patients by mouth. Antibiotics should be administered until the perforation is healed. Contrast EG or endoscopic examination should be performed before resuming oral feeding. Oral feeding is recommended when no esophageal leak is observed; clinical and laboratory follow-up should be done simultaneously. Long-term therapy for unhealed perforations is esophagectomy and gastric reconstruction (2,16). One of our patients was diagnosed with esophageal perforation that was repaired via right thoracotomy. No surgery was scheduled for patients with esophageal perforation secondary to prolonged FBs exposure and these patients were treated conservatively.

CONCLUSION

FBs lodged in the esophagus should be removed as early as possible. Therefore, physicians working in secondary care should be able to distinguish coins and FBs by radiologic imaging. Our results suggest that increased duration of esophageal contact increases morbidity and mortality of patients.

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Table 1: Clinical characteristics of the patients.

N	Age (month)	Localisation (stricture ½)	Time from ingestion to presentation (hour)	Duration of hospital stay (day)	Gender	Complication
1	12	1	6	3	Female	
2	12	1	8	2	Female	
3	24	1	5	2	Male	
4	12	1	72	37	Female	Exitus
5	20	1	48	34	Female	Stenosis
6	22	1	48	15	Female	
7	16	1	96	62	Female	Exitus
8	12	1	48	24	Female	Fistula
9	11	1	4	2	Female	
10	10	2	4	2	Female	
11	6	2	8	8	Male	
12	10	1	5	3	Female	
13	60	1	6	3	Male	
14	29	3	8	3	Female	
15	10	2	10	7	Female	
16	10	1	5	2	Male	
17	10	2	25	15	Female	Stenosis
18	12	1	3	2	Female	
19	15	1	6	4	Female	
20	3	1	6	6	Male	
21	15	1	10	8	Female	
22	48	1	26	13	Male	
23	120	1	30	15	Female	Stenosis
24	24	1	10	4	Male	
25	36	1	5	3	Male	
26	11	2	6	2	Female	
27	13	1	8	3	Female	
28	30	2	11	5	Female	
29	12	1	12	8	Male	
30	13	2	4	6	Male	
31	21	1	7	8	Female	
32	94	3	13	4	Male	

Table 2. Clinical characteristics of the patients.

		Count	Column N %
Gender	Female	21	65,6
	Male	11	34,4
Localisation	Stricture 1	25	78,1
	Stricture 2	6	18,8
	Stricture 3	1	3,1
Duration of battery stay	First 24 hours	24	75,0
	More than 24 hours	8	25,0
Complication	None	26	81,3
	Present	6	18,8
Mortality	Surviving	30	93,8
	Died	2	6,3
Annual number of cases	1990	1	3,1
	1997	1	3,1
	2002	1	3,1
	2004	2	6,3
	2005	2	6,3
	2006	3	9,4
	2007	1	3,1
	2008	1	3,1
	2009	2	6,3
	2010	4	12,5
	2011	4	12,5
	2012	2	6,3
	2013	4	12,5

2014	4	12,5	

Table 3: A linear regression analysis of the number of cases

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,803	,644	,628	,91125

a.Predictors: (Constant), year

b. Dependent Variable: number of battery

		N	Mean	Std. Deviation	Std. Error Mean
Number of Cells	The first 12 years	12	,2500	,45227	,13056
	last 12 years	12	2,4167	1,37895	,39807

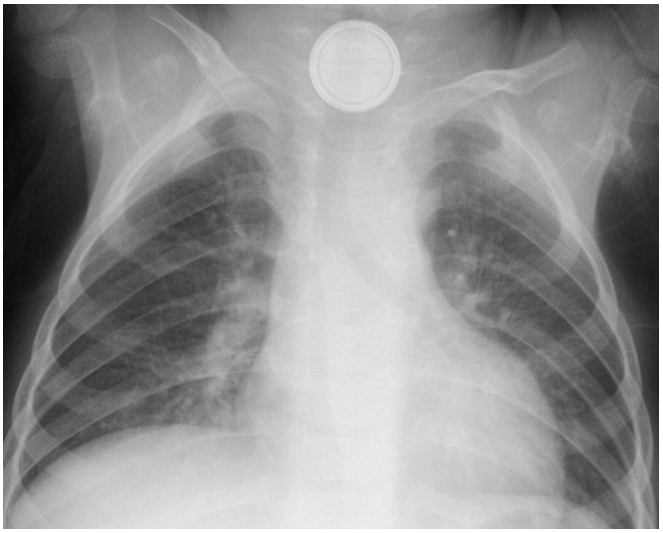

Fig.1: The apperence of the battery in the chest X-ray

Fig.2: Stenosis seen in esophagoscopy

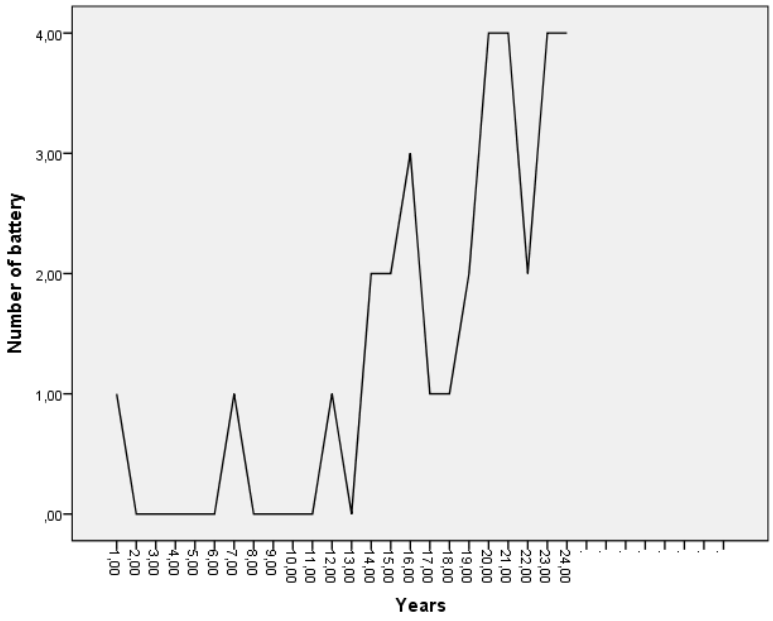

Fig.3: Number of ingested batteries by years

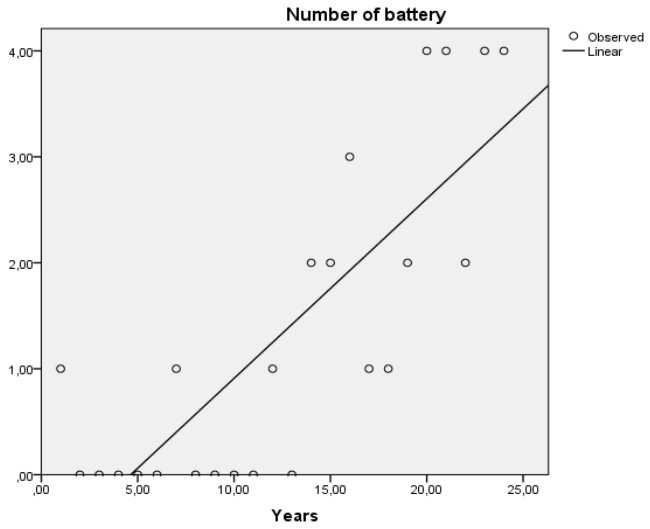

Fig.4: Linear regression model between years and numbers of batteries

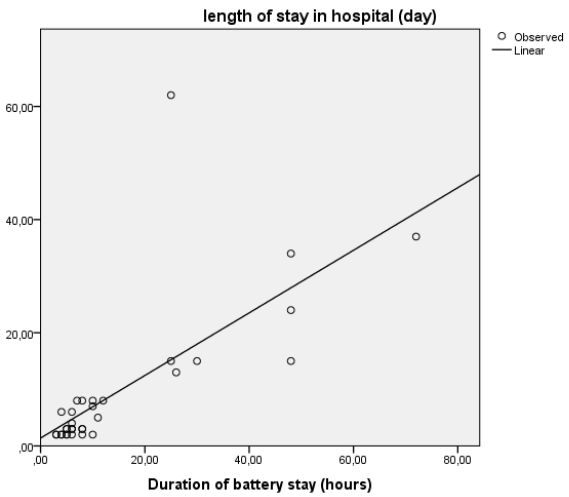

Fig.5: Linear regression model between duration of battery stay and lenght of hospital stay