

Original Article

Diagnosis and treatment of foreign body perforations of the digestive tract in children

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Abstract: Aim: The aim of this study was to investigate clinical characteristics and management of perforations of the digestive tract with foreign bodies (FB) in children. Methods: This study retrospectively analyzed clinical manifestations, FB types, perforation sites, treatments, and prognoses of 13 children diagnosed with gastrointestinal perforations with FBs. Results: Of the 13 cases, four cases were upper digestive tract perforations with FBs in the esophagus and perforation sizes were 0.8-1.2 cm. Nine cases were lower digestive tract perforations with FBs in the ileum (four cases), jejunum (two cases), colon (one case), and rectum (two cases), with perforation sizes of 0.5-0.8 cm. Of the 13 cases of perforations, seven cases were single-site-perforation and six cases were double-site-perforations. FBs included three cases of jujube nuclei, three cases of thermometers, four cases of magnets, one case of button battery, one case of sunflower shell, and one case of chicken bone. Conclusion: As sharp or multiple magnetic digestive tract FBs can cause one or more perforations and damage to peripheral blood vessels, along with other serious complications, close inpatient observation is required. Patients confirmed to have ingested sharp FB with vomiting, hematemesis, eating difficulty, abdominal distention or abdominal pain, or multiple magnets should be regarded as conditional surgical patients.

Keywords: Gastrointestinal tract, foreign body, perforation, children

Introduction

Ingestion of a foreign body (FB) occurs commonly in children between six months and six years of age [1]. They have a natural tendency to explore objects with their mouths. In the United States, a total of 94,820 cases were reported in 2015, with 68,371 of these cases occurring in pediatric patients aged \leq five years [2]. The majority of ingested FBs pass spontaneously and conservative treatment is sufficient in most cases of FB ingestion [3]. In recent years, due to the popularity and development of endoscopy, chances of complications and surgical treatment have been reduced. However, the exact locations of some special foreign bodies and their relationships with surrounding organs cannot be determined. This often leads to perforation of the digestive tract, affecting peripheral blood vessels. This study aimed to summarize the clinical characteristics of 13 cases of children with digestive tract perforation with FBs, confirmed by imaging diagnosis or operations, in Yuying Children's Hospital

Affiliated to Wenzhou Medical University, from 2009 to 2017.

Material and methods

Research subjects

This study was approved by the Ethics Committee of the 2nd Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University. Informed consent was obtained from each participant's guardian. From January 2009 to August 2017, there were 13 children diagnosed with perforations of the digestive tract, by imaging or surgery, in Yuying Children's Hospital Affiliated to Wenzhou Medical University. They were admitted to the Pediatric Emergency Department and treated in the Resuscitation Room. Two children were then transferred to the Children's Digestive Department. Another two children were transferred to the Pediatric Thoracic Surgery Department, while the other nine children were transferred to the Pediatric Surgery Department. Ages ranged between six months to eight years

Foreign body perforations of the digestive tract in children

Table 1. Clinical data of 13 cases of digestive tract foreign bodies with perforation

Record number	Age (months)	Gender	The main statement	Hospitalization time (days)
1	24	Female	Mistook button battery for 1 d	15
2	13	Male	Difficult eating for 5 d	13
3	96	Female	Foreign body in esophageal for 5 d, hematemesis for 1 d	53
4	18	Male	Swallowed red dates for 1 w, fever for 5 d	47
5	6	Male	Thermometer broken in the anus for 10 h, ventosity, and cyanosis for 0.5 h	9
6	13	Female	Found rectal foreign body for 2 d	9
7	15	Male	Bloating, vomiting with stop defecation for 41 h	19
8	24	Male	Repeated fever for 20 d, abdominal pain for 1 d	9
9	24	Male	Thermometer broken in the anus for 10 h	14
10	14	Male	Vomiting for 2 d	14
11	96	Male	Vomiting with fever for 2 d	19
12	48	Female	Abdominal pain with vomiting for 2 d	17
13	48	Male	Abdominal pain with vomiting for 8 h	11



Figure 1. Abdomen film on erect position suggesting intestinal obstruction.



Figure 2. Chest and abdomen film on erect position prompting abdominal round foreign body.

(two children were less than one year old, eight children were one to three years old, and three were older than three years old), with an average of 27.000 ± 24.593 months old (nine boys and four girls) (Table 1).

Results

Clinical features

There were five cases with fever, five cases with vomiting, one case with hematemesis, two

cases with eating difficulties, two cases with abdominal distention, three cases with abdominal pain, one case with cyanosis, and one case with paleness. There were five cases with WBC elevation ($15.7-24.2 \times 10^9/L$) in routine blood tests, four cases with C reactive protein elevation (10-139 mg/L), two cases with hemoglobin decreases, and one case with liver function impairment (alanine aminotransferase 72 U/L,

Foreign body perforations of the digestive tract in children

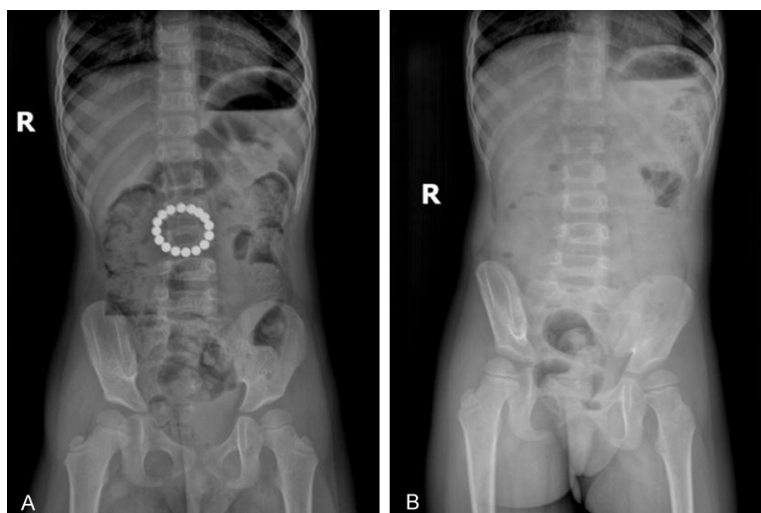


Figure 3. A: 16 high-density shadows with 6 mm diameter size in abdomen. B: Abdomen film on erect position after removal of foreign body.



Figure 4. Pelvic high-density heterogeneous shadow.

aspartate aminotransferase 95 U/L). There were seven cases with confirmed FB ingestion, but FB ingestion was not witnessed in six cases. The shortest course of the disease was eight hours and the longest was 20 days. Hospital stays were 19.154 ± 14.171 days (range: 9-53 days).

Imaging examination

All cases were given imaging examinations. Chest CT tipped a foreign body of the upper end of the esophagus, with throughout expansion, in one case. Chest CT enhancement prompted thoracic aortic pseudoaneurysm in one case. It was detected as a $27 \times 25 \times 50$ mm liquid dark area by B-ultrasound, connecting with the abdominal aorta lumen. Tube wall echo inter-

ruption was 4 mm. Abdomen upright flat tablets suggested intestinal obstruction in two cases, as shown in **Figure 1**. Chest and abdomen upright flat film prompted an abdomen round foreign body in three cases, as shown in **Figures 2, 3**. Abdominal B-ultrasound suggested the strip strong echo of a right lower abdomen foreign body and abdominal CT suggested a pelvic foreign body shadow in one case, shown in **Figure 4**. Abdominal B-ultrasound and upright flat tablets suggested intestinal flatulence and intestinal effusion in one case.

There were endoscopic changes in four cases, with tipping large fragments of erosion seen in upper 3-4 cm mucosa of the esophagus, shown in **Figure 5**. Endoscopic esophageal perforation was displayed in three cases.

Treatment and healing

After admission to the hospital, patients underwent treatments for the following reasons: 1) Failure to spontaneously pass ingested foreign materials; 2) Sudden-onset abdominal pain, vomiting, hematemesis, eating difficulty, or abdominal distention during hospitalization; 3) Perforation incidentally discovered during gastroduodenoscopies. Of the patients, 10 were fasted and received abrosia rehydration support and gastrointestinal decompression, one was given cefuroxime injections to combat infections, three were given cefoperazone to resist infections, two cases received meropenem for anti-infection, six were treated with imipenem, one mucosal erosion patient was given dexamethasone to prevent scar formation, nine were given omeprazole acid, three patients were supplemented with albumin, and three were infused with red blood cells. Of the 13 children, four had FBs in the upper gastrointestinal tract and nine were in the lower digestive tract. They had different degrees of perforation, including one perforation in seven cases and two perforations in six cases. Four cases of esophageal dissection were removed through the endoscopic clamp, in which one case of FB

Foreign body perforations of the digestive tract in children

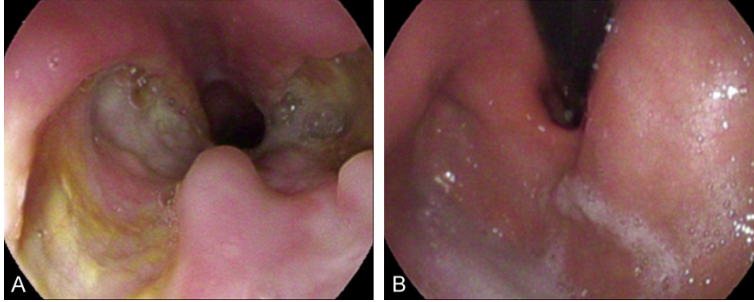


Figure 5. A: One week after the removal of the battery button, endoscopy found in the upper esophageal 3-4 cm mucosa a large erosion, covered with yellow and white scab, easily bleeding after touching. B: Endoscopic examination of normal mucosa after 10 days.

was incarcerated esophageal. After the FB was clamped, the patient's esophagus was perforated, with the hematemesis appearing. The patient was treated for an esophageal rupture (**Figure 6A**). Due to thoracic aortic perforation and thoracic aortic aneurysm formation, the patient underwent thoracic aortic repair in the off-pump (**Figure 6B**). Because of thoracic aortic perforation and thoracic aortic aneurysm formation, the patient underwent thoracic aortic repair (**Figure 6C**). One patient received mediastinal incision pus after removal of esophageal FB one week later. During treatment, there were two cases of pulmonary infections. Nine cases of digestive tract FB were removed by surgery. In the 13 cases, three children improved and 10 were cured. There were two patients suffering from fistula, selecting a date for the second phase of surgical treatment. Endoscopic, laparoscopic, and laparoscopic-assisted procedures have been increasingly performed, but they cannot be used in the place of conventional laparotomy in lower digestive tract perforations with FBs. Specific types of surgery are shown in **Table 2**.

Discussion

Digestive tract FB is common in children, as infants and young children like to explore objects by putting them into their mouths [4]. With FB through the esophagus into the stomach, 90% can be self-discharged [5]. Cases of children's upper digestive tract FB usually involve coins, caps, and so forth. Endoscopic clamps are still the preferred method, with lesser complications [6, 7]. Adult digestive FBs are common in fish bones [8, 9], mostly getting through the gastrointestinal tract or remaining in the upper gastrointestinal tract [10].

Endoscopy is a safe and effective method [11], but also leads to colon perforation [12, 13]. Subjects that have passed the esophagus generally do not have symptoms unless complications, such as bowel perforation or obstruction occur. Some special digestive tract FBs can lead to serious complications. Reasons for this include: 1) If the shape is too long, FB cannot pass through the gastrointestinal tract of the bend. Especially

in the bend between second and third segments of the duodenum. Easily leading to perforation; 2) The foreign substance is too large to cause an obstruction through the pylorus; 3) Sharp foreign bodies easily penetrate the intestinal wall and cause perforation. If the maximum diameter of FBs > 30 mm and embedded time > 40 hours, it will be an endoscopic removal of the foreign body [14]. Patients may develop abdominal pain and tenderness, nausea, vomiting, fever, hematemesis, or melena. Four cases of esophageal FBs in this group were removed by endoscopic FB clamp surgery. Nine cases of lower foreign digestive tract FBs were removed by surgery. In this group of FBs, sharp ones were three jujubes, one was a sunflower shell, and one was a chicken bone, while the long ones were three thermometers.

Imaging examinations of the digestive tract FB and perforation are of great value. Radiographic studies may show free air or a dilated bowel. Multidetector computed tomography has the characteristics of high spatial resolution and high quality reconstructed images, accurately determining the presence and location of gastrointestinal perforations [15]. Mohsen Ebrahimit [16] discovered rare glass in a stomach through the abdomen plain film. It has been reported that, among adult digestive tract FBs, stomach, duodenum, and colorectal FB perforations with clinical manifestations are relatively light, but continue longer than jejunum and ileal perforation injuries [17]. The present study found that esophageal FBs can cause severe vascular damage if they lead to esophageal perforations and are adjacent to large vessels. Seven cases of this group of patients had clear histories of FB. FB misappropriation history of six cases was not clear. All cases were given

Foreign body perforations of the digestive tract in children

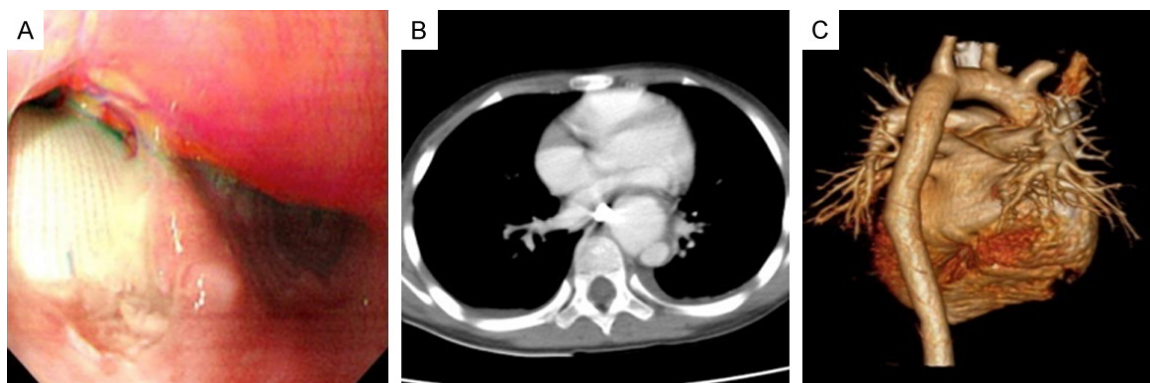


Figure 6. A: Endoscopic esophageal rupture titanium clip closure treatment. B: Chest CT enhancement prompted thoracic aortic pseudoaneurysm, class round slightly higher density, enhanced scan enhancement and thoracic aorta similar, size 25×27 mm. C: Thoracic aortic pseudoaneurysm after surgery, CAT lumen clear, intimal intact.

imaging examinations. Chest CTs found FB and thoracic aortic aneurysm in one case, abdominal upright flat tablets prompted intestinal obstruction in two cases, three cases of abdominal FB, intestinal flatulence and intestinal effusion in one case, and esophageal foreign body one case. Abdominal CTs revealed a pelvic high-density foreign body shadow in one case, endoscopic esophageal upper mucosal erosion in one case, and perforation in three cases.

The present study showed four cases of upper gastrointestinal FB in 13 cases, perforation position in the esophagus, 9 cases of lower digestive tract FB, perforation in 4 cases of ileum, 2 cases of jejunum, 1 case of the colon, and 2 cases of the rectum. Foreign matter was discovered, including jujube and thermometers in 3 cases, magnets in 4 cases, a button battery in 1 case, a sunflower shell in 1 case, and a chicken bone in 1 case. Incidence of complications caused by sharp FBs is 1-15%, or even 35% [18]. Sharp FBs can lead to gastrointestinal bleeding, abscess formation, mediastinitis, and perforations leading to peritonitis [19, 20]. Such cases require surgical treatment, but the cure probability is less than 1% [1]. Six cases of children had peritonitis, receiving abdominal rinsing and anti-infective treatment. Chicken bones, jujubes, and other sharp FBs cause greater risks of perforation. Jujubes have two sharp edges, easily leading to two perforations. One case was an 8-year-old girl with a clear history of chicken bruises. Chicken bones are sharp and hard, causing perforations of the esophagus and affecting peripheral blood ves-

sels. Hematemesis appeared in the fourth day after esophagus endoscopic removal of the chicken bone, complicated by esophageal perforation, thoracic aortic aneurysm, perforation, and other serious complications. Hematemesis occurred on day four of the course of the disease. It is worth mentioning that an 8-month-old child went to the doctor due to “vomiting and fever for two days”, with no clear foreign body swallow history. Abdominal ultrasound and abdomen film only prompted intestinal flatulence and intestinal effusion, with no FB showing. Due to repeated vomiting, the doctor once again asked for patient history. Family members remembered they were nibbling sunflower seeds when their child was sitting around and playing two days earlier. Caesarean section revealed that the sunflower shell resulted in intestinal perforation. Early intervention is indicated for patients that have swallowed button or disc batteries because of the potential for voltage burns and direct corrosive effects. Burns can occur as early as four hours after ingestion [21]. It has been found that magnetic material could corrode the digestive tract mucosa, leading to perforation. The present case prompted even though button battery had been removed. Endoscopy still found esophageal 3-4 cm mucus large erosion one week later. Battery FBs in the esophagus can lead to serious complications, even if the child is asymptomatic. Also, it is important to immediately use an endoscopic clamp. Persistent damage to the mucosa should not be ignored. Button batteries that remain in the stomach for more than 48 hours or that are larger than two cm in diameter should be removed endoscopy-

Foreign body perforations of the digestive tract in children

Table 2. The 13 cases of foreign bodies with digestive tract perforation including foreign body species, perforation, and surgical methods

Patient no.	Position	Foreign Body	Treatment methods
1	Esophagus	Button battery	Endoscopic foreign body forceps removal
2	Esophagus	Jujube nucleus	Endoscopic foreign body forceps removal
3	Esophagus	Chicken bone	Endoscopic foreign body forceps removal + Closure of esophageal rupture with titanium clip + Repair of aortic rupture + Jejunostomy with jejunostomy
4	Esophagus	Jujube nucleus	Endoscopic removal of foreign body from esophagus + Mediastinal incision drainage
5	Colon	Thermometer	Foreign body removal + Abdominal drainage + Colon repair
6	Rectum	Thermometer	Laparoscopic exploration + Foreign body removal
7	Ileum	Magnet	Laparotomy + Abdominal rinse and foreign body removal + Intestinal perforation repair
8	Ileum	Jujube nucleus	Laparotomy + Abdominal rinse and foreign body removal + Intestinal perforation repair
9	Rectum	Thermometer	Laparoscopic exploration + Foreign body removal
10	Jejunum	Magnet	Intrahepatic foreign body removal surgery + Abdominal rinse + Bowel resection
11	Ileum	Sunflower seeds	Laparotomy + foreign body removal + intestinal adhesion release + end ileum fistula
12	Jejunum	Magnet	Laparotomy + abdominal rinse and foreign body removal surgery + intestinal perforation repair
13	Ileum	Magnet	Intestinal excision of foreign body removal + bowel resection and intestinal decompression + abdominal cavity irrigation

Foreign body perforations of the digestive tract in children

cally. Once they are past the duodenal sweep, 85 percent of button batteries pass in less than 72 hours. Radiographs should be obtained every three to four days to follow the progress of the battery until it has been passed [22]. Intake of multiple magnets can damage the intestines [23] and even cause occurrence of intestinal obstruction and perforations of the fistula [24]. In particular, ingestion of magnetic materials can cause serious morbidity due to proximate attraction through the intestinal wall. The present study showed that four cases of children had intestinal perforations due to misuse of multiple small magnets. Patients ingested more than two magnets in this group of cases, including 16 small magnets in one case. More than two magnets may cause intestinal adsorption, internal fistula, and double perforations. In another case, due to ingestion of a chicken bone, esophageal perforation occurred. The doctor carried out jejunum catheterization fistula. In a case of perforation of ileum, terminal ileostomy was carried out, with a second phase of surgical treatment needed. These serious gastrointestinal complications caused by special FBs require early and proper assessment and intervention.

The present study concludes that digestive tract FBs are often treated in children's emergency medicine, with no clear swallowing history of jujube nucleus, thermometers, sunflower seeds, and other sharp slender foreign bodies including magnets, button batteries, and other magnetic FBs. These cause gastrointestinal perforations and other serious complications. For children < six years old with unexplained vomiting, abdominal pain, and abdominal distension, digestive tract FBs should be suspected. Emergency departments should conduct imaging and contact relevant departments for consultation. Attention should be paid to hidden clinical complications for early intervention, while doing a good job on the digestive tract FB size, location, and potential complications assessment. Due to serious complications and the high cost of hospitalization, it is imperative that public education be carried out to prevent this issue.

Disclosure of conflict of interest

None.

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Foreign body perforations of the digestive tract in children

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