Successful removal of multiple magnetic foreign bodies in the digestive tract of children by gastroscopy

Two case reports
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Abstract
Rationale: Gastrointestinal foreign body (FB) is an emergency commonly encountered by the pediatric gastroenterology department. Management of their extraction requires knowledge and careful consideration of removal techniques.

Patient concerns: Two little girls swallowed multiple magnets that stuck together for >3 days, which was an indication for surgery.

Diagnosis: X-ray revealed dense shadows in the left abdomen. However, the abdominal examination revealed a soft abdomen without tenderness, rebound tenderness, or muscle rigidity.

Intervention: The multiple magnets were removed by endoscopy instead of surgery.

Outcome: We conducted sufficient preoperative assessment and preparation. Eventually, we successfully removed the multiple magnets by endoscopy, and no perforation or fistula formation was observed. Surgery was avoided.

Lessons: Swallowing multiple magnets isn’t a rare emergency in children. Physicians must be aware that surgery is not the only option even if multiple magnets are swallowed for >12 hours. Endoscopic removal can be considered if there is no obstruction, perforation, or fistula formation upon careful patient assessment. If endoscopic removal fails, surgical treatment should be performed as soon as possible to avoid serious complications.

Abbreviation: FB = foreign body.

Keywords: children, gastroscopy, magnetic foreign bodies

1. Introduction
Most gastrointestinal foreign bodies (FBs) occur in children between the age of 6 months and 6 years, mostly ingested while they were playing. Some children may have impaired gag reflex, esophageal stenosis, esophageal dyskinesia, or esophagitis, which causes foreign bodies more easily trapped in the gastrointestinal tract. Ingested FBs can cause serious morbidity or mortality depending on their size, shape, and the patient’s physical condition; therefore, endoscopic or surgical removal is mostly required.

We recently treated 2 pediatric patients who ingested several magnetic FBs. Here we report 2 cases to illustrate the non-surgical management strategy for magnetic FB ingestion.

2. Case presentation
The clinical characteristics of the 2 patients are presented in Table 1.

2.1. Case 1
A 3-year-old girl was admitted to the hospital because of ingestion of FBs (magnets) 3 days prior to admission on February 3, 2016. She had no symptoms of abdominal pain, vomiting, or fever, but the magnets were not passed 3 days after ingestion. Subsequently, the patient visited the Department of Pediatric Gastroenterology, and x-ray revealed a dense shadow in the left upper abdomen (Fig. 1). The abdominal examination revealed a soft abdomen without tenderness, rebound tenderness, or muscle rigidity, and normal bowel sound was heard. So retention of ingested gastrointestinal foreign bodies was diagnosed. After completing the preoperative examination, gastroscopy was performed under general anesthesia with endotracheal intubation. The child was...
placed in the left lateral position, and the gastroscope was passed through the mouth into the esophagus. In the normal fashion the mucosa appeared normal. Close to the Z-line, a 0.4 cm roundish magnet was seen embedded in the esophageal wall, and congestion and edema were observed in the surrounding mucosa. The gastroscope was then further advanced into the stomach, and retroflexion of the scope revealed another round magnet at the gastric fundus (near the cardia). The gastric magnet and the esophageal magnet were firmly attracted to each other with gastric and esophageal mucosa between them. The foreign body forceps were first inserted and grabbed the bottom of the gastric magnet. Considerable grabbing force was applied to overcome the attracting force between the magnets and they were eventually separated. The gastric magnet was then removed by withdrawing the gastroscope. The gastroscope was inserted again to look for the other magnet in the lower esophagus, which had been dislodged. The gastroscope was advanced into the body of the stomach, a circular ulcer was observed in the antral mucosa with its crater reaching the muscular layer. There were congestion and edema in the surrounding mucosa and a small amount of local bleeding was seen. The other magnet was later found adhered to the gastroscope and was removed by withdrawal of the gastroscope (Fig. 2). Postoperatively, no complication occurred. A nasogastric tube was used to maintain nutritional intake. Abdominal computed tomography was performed, and revealed no complications.

2.2. Case2
A 3-year-old girl was admitted to our department because of ingestion of multiple magnetic balls 6 days prior admission on August 9, 2018. She had abdominal pain, without vomiting, fever, or hemorrhage. The magnets were not passed 6 days after ingestion. The abdominal examination was normal. X-ray indicated the presence of 5 dense round shadows in the left middle abdomen (Fig. 3). After completing the preoperative investigations, gastroscopy was performed under general anesthesia with endotracheal intubation. The child was placed in the left lateral position, and the gastroscope was passed through the mouth into the esophagus in the normal fashion. The magnesia appeared normal. We found 2 global magnets in the gastric body, one was seen embedded in the gastric wall, and congestion and edema were observed in the surrounding mucosa. The gastroscope was then further advanced into the duodenum and 3 spherical magnets were seen. Two were embedded in the duodenal wall, and congestion and edema were observed in the surrounding mucosa. The gastric and duodenal magnets were firmly attracted to each other with gastric and duodenal mucosa in between. The foreign body forceps were first inserted and grabbed the bottom of one of the duodenal magnets. Considerable grabbing force was to overcome the attracting force between the magnets and the magnets were separated and the 3 duodenal magnets were eventually removed with a foreign object basket. A circular ulcer was observed in the duodenal mucosa with its crater reaching the muscular layer. The gastroscope was advanced into the body of the stomach, then the foreign body forceps was inserted and used to grab the bottom of the gastric magnet. The 2 gastric magnets were eventually removed with a foreign object basket. A circular ulcer was observed in the mucosa with its crater reaching the muscular layer (Fig. 4). Postoperatively, no complication occurred. A nasogastric tube was used to maintain nutritional intake. Abdominal x-ray was performed, and revealed no complications (Fig. 5).

3. Discussion
In pediatric patients, gastrointestinal FBs mostly include coins, buttons, batteries, magnets, small toys, pieces of jewelry, plastic
sheets, and fruit stones. High-risk FBs require emergency endoscopic treatment, whereas “innocuous” foreign bodies, if not passed spontaneously, often need elective endoscopic treatment.[3]

Swallowed magnets account for about 2% of gastrointestinal FBs,[4] and the incidence has significantly increased in recent years. If a single magnet is swallowed without any symptoms, rigorous evaluation and close follow-up should be conducted. If the magnet has passed through the esophagus, the possibility of spontaneous egestion is high. If passage is delayed, a stool softener or polyethylene glycol should be administered. If the magnet does not move, endoscopic removal or surgical intervention should be performed immediately.

If >1 magnet is swallowed, magnets can become attracted to each other and may exert pressure on the intervening digestive tract wall, easily causing ischemic necrosis, perforation, fistula formation, obstruction, peritonitis, and other serious gastrointestinal damage. If FBs press on the mesenteric blood vessels, intra-abdominal bleeding can occur.[5] If >1 magnet is found in the stomach or esophagus, endoscopic removal is recommended within 12 hours even in the absence of symptoms. If >12 hours have elapsed, consultation with and evaluation by the Department of Surgery is required. If the magnet has passed through the pylorus and there is no obstruction, perforation, or other symptoms, the magnets can be removed by colonoscopy; however, if symptoms develop, immediate surgical intervention is required.[6]

Swallowed gastrointestinal FB is a common emergency in children. If not spontaneous passed, endoscopic and surgical
Procedures are the main treatment methods for gastrointestinal FBs.\textsuperscript{[7]} Endoscopic treatment is preferred, as it is less traumatic, safe, has a high success rate, and associated with few complications.\textsuperscript{[8]} In the present cases, the 2 patients swallowed multiple magnets that stuck together, making them a special type of FB ingestion. It is associated with higher risk and more difficulty for endoscopic removal. The main difficulties were as follows: FBs were magnets with high attractive magnetic force and they were not easy to separate with foreign body forceps. It is difficult to manipulate the metallic foreign body forceps in the vicinity of the magnets because the magnetic field interferes with the normal operation of the forceps. Moderate force should be applied to separate the magnets because excessive force may dislodge the other magnet resulting in flipping of the magnet to the opposite side with the magnets adhering to each other again. This may result in the occurrence of perforation and fistula formation. But if the force is too weak, it would be difficult to overcome the attracting force between the magnets. For this special type of foreign body, preoperative consultation with staff of the Department of Pediatric Surgery is necessary to weigh the pros and cons of the endoscopic retrieval and ensure adequate preoperative preparation in case immediate surgical intervention is needed upon failure of endoscopic removal.

In the 2 cases, the patients swallowed multiple magnets that stuck together for $>3$ days, which was an indication for surgery. We conducted sufficient preoperative assessment,
obtained the parent’s consent and assistance from staff of the Department of Surgery, and performed adequate preoperative preparation. Eventually, we successfully removed the multiple magnets by endoscopy, and no perforation or fistula formation was observed. Surgery was avoided. Even if the magnets are swallowed for >12 hours, endoscopic removal can be considered if there is no obstruction, perforation, or fistula formation upon careful patient assessment. If endoscopic removal fails, surgical treatment should be performed as soon as possible to avoid serious complications.

Author contributions
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