

Ingestion of magnetic foreign bodies causing multiple bowel perforations

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Abstract We report a 3-year-old boy who presented to the emergency room with the suspicion of having swallowed an unknown number of industrial metallic objects, subsequently shown to be magnets. During the hospital course, the boy developed multiple bowel perforations caused by the swallowed magnets that were attracted across the bowel walls. The patient management was delayed as the radiographic appearance of the foreign object did not immediately reveal that multiple magnets were stuck to one another. By this report we aim to alert the radiological and pediatric community to the possible presentation of multiple magnet ingestion. If multiple magnets or a combination of magnets and metallic objects are suspected, immediate radiographic evaluation is warranted for confirmation, and urgent surgical exploration may be necessary to prevent bowel perforation and/or intraabdominal abscess formation.

Keywords Magnets · Foreign body ingestion · Emergency · Child

Introduction

Foreign body ingestion by infants and children is relatively common, particularly in an imaging practice at a large children's hospital. Although morbidity associated with such ingestions is infrequent (<1%), when complications occur, there is also a relatively high rate of mortality, with death rates as high as 1,500 deaths per year in the United States [1, 2]. A particularly ominous scenario is the ingestion of multiple magnetic objects, which, when located in different loops of bowel, can attract each other and cause pressure necrosis of the bowel wall and subsequent perforation. Although several examples of ingestion of multiple magnets have been reported in the pediatric surgical literature, there has been modest discussion in the pediatric literature, and minimal discussion in the radiological literature, with the exception of an alert by Oestreich [3]. Radiologists and pediatricians should be aware of the potential radiographic presentation, especially as ingestion frequently occurs unwitnessed and the swallowed objects may not be known.

We describe a child who swallowed three magnets, which ultimately resulted in multiple perforations in both the small and large bowel.

If a pediatric health-care provider suspects that more than one magnet has been ingested by a pediatric or adolescent patient, an immediate radiographic evaluation for foreign body is recommended. This evaluation would include a frontal radiograph of the chest, a frontal radiograph of the abdomen and pelvis, and a lateral radiograph of the neck. If more than one metallic foreign body suspected by a radiologist to be a magnet is located beyond the stomach on an abdominal radiograph, the surgical service should be immediately alerted to the

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potential danger of the situation, which includes a high risk of bowel perforation and abscess formation.

Case report

A 3-year-old boy presented to an emergency room at a large, urban tertiary care children's hospital with abdominal pain and the suspicion of having swallowed an unknown number of industrial magnets. An initial radiograph demonstrated what was thought to represent a single bar-shaped metallic object in the right lower quadrant, without signs of bowel obstruction or perforation (Fig. 1). Because only one foreign body was suspected, the clinical decision was to wait and observe the patient for expected spontaneous passage of the object. On hospital day 2, a follow-up abdominal radiograph showed the object in an unchanged

position but demonstrated increased bowel distension, suspicious for early obstruction (Fig. 1). In addition, because the object(s) were imaged at a slightly different angle, two unequally spaced gaps could be visualized within the metallic object (Fig. 1). A suspicion of more than one ingested object was not raised prospectively, partially because the shape of the ingested object(s) were unknown and no free air was seen to suggest the presence of bowel perforation. A subsequent radiograph demonstrated free intraabdominal air, and an emergency exploratory laparotomy was performed. During surgical exploration, a total of three identical round, hollow magnets were found stuck together near the terminal ileum. Six round, sharply margined holes exactly matching the sharp edges of the magnets were found in different loops of small and large bowel, which were over sewn. Five holes were located in the jejunum and ileum and one was found in the cecum.

Fig. 1 Abdominal radiographs. **a** Admission radiograph shows a single metallic object in the right lower quadrant. **b** Subsequent radiograph with beam perpendicular to the object demonstrates that the presumed "single" object in fact consists of three separate magnets; *magnified insert* demonstrates spaces between individual magnets (*arrows*). **c** Day 2 radiograph with magnets in unchanged position. New air fluid levels indicate beginning bowel obstruction. **d** Free intraabdominal air is demonstrated on upright and lateral decubitus views (*arrows*)

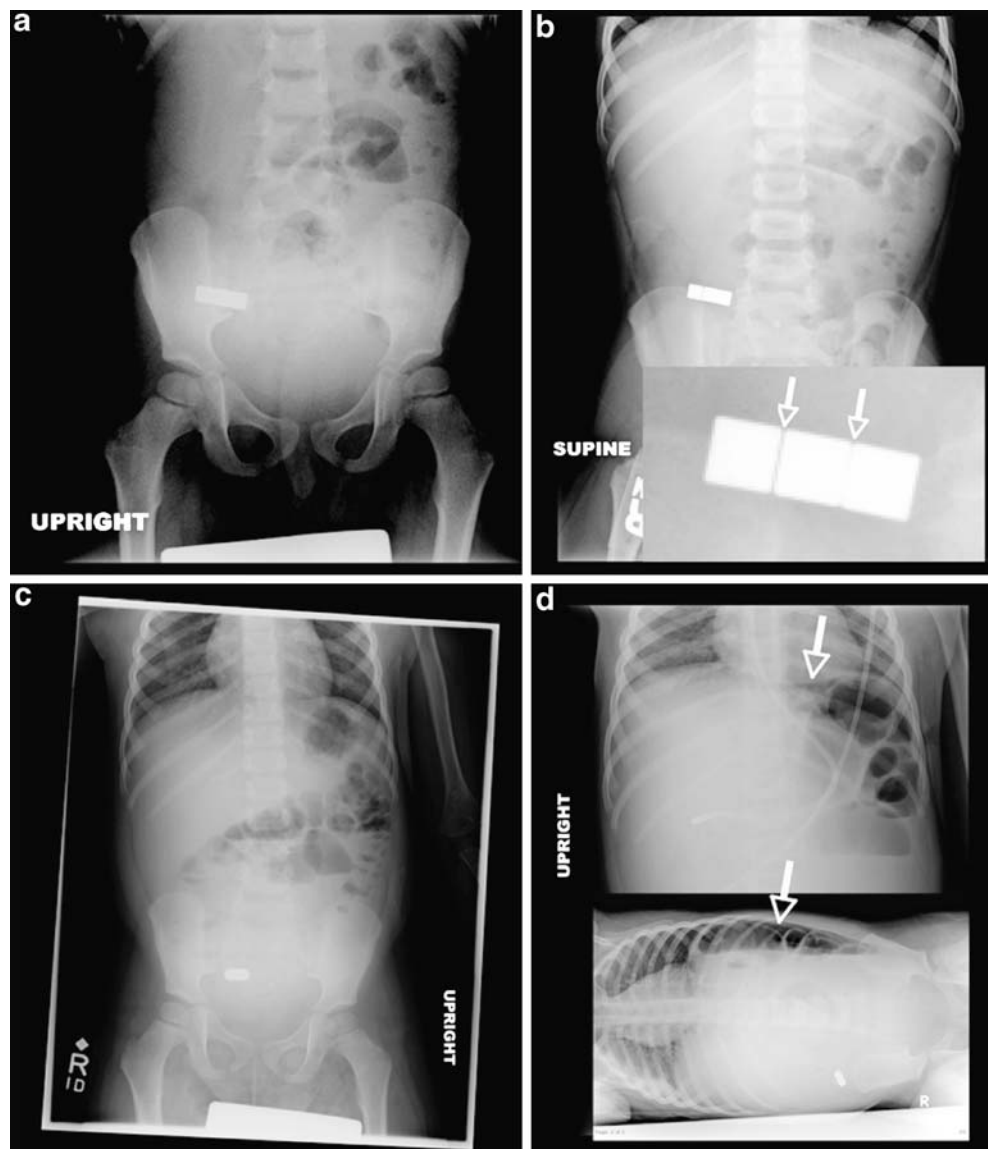
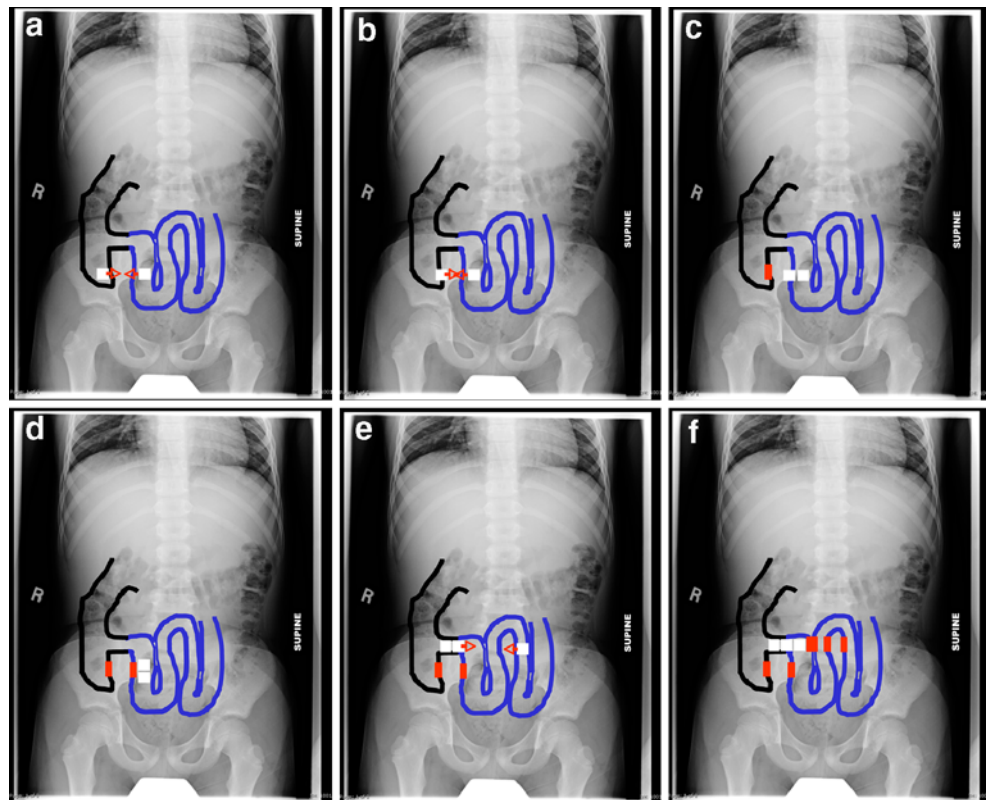


Fig. 2 Proposed mechanism of three magnets causing multiple perforations in the small bowel and one perforation in the cecum. **a** Magnet 1 has reached the cecum and attracts magnet 2 located in the ileum. **b–d** Pressure necrosis causes perforations in the cecum and terminal ileum. **e** Magnet 1+2 in the terminal ileum attracts magnet 3 in the jejunum. **f** Six perforations have occurred—five in the small bowel and one in the cecum

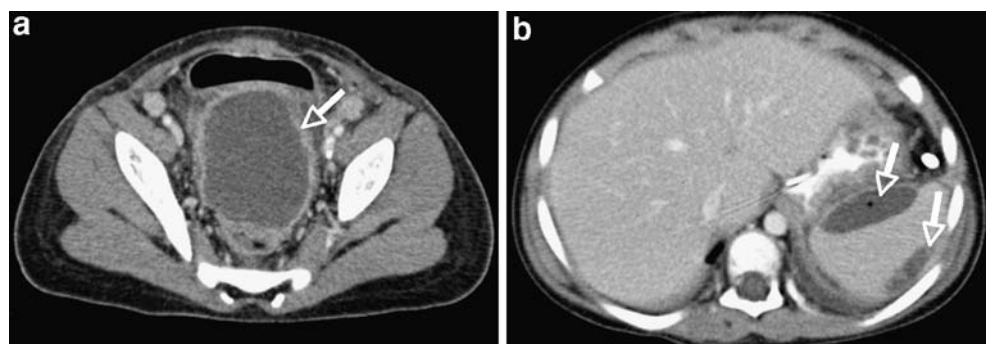


Bowel perforation by ingested magnetic foreign bodies is caused by pressure necrosis in two adjacent loops of bowel, each of which contains a magnetic foreign body. The distribution of the holes suggests that two magnets that attracted each other initially created the holes in the cecum and terminal ileum. The remaining holes were likely caused by attraction between those two previously attached magnets and a third magnet, which was located more proximally (Fig. 2). Surgical exploration demonstrated widespread spillage of succus entericus throughout the abdominal cavity. The patient ultimately developed multiple abscesses in the pelvis, spleen, liver and kidneys (Fig. 3) requiring multiple drainage procedures. Intermittently in critical condition, the patient recovered after a 4-week hospital stay and was eventually discharged in stable condition.

Discussion

Foreign body ingestion is relatively common in the pediatric population, most often involving children between the ages of 6 months and 3 years. In 1999, the American Association of Poison Control documented more than 180,000 incidents of foreign body ingestion by patients younger than 20 years [1, 2]. Diagnosing and treating ingestions in infants and young children can be difficult because an accurate ingestion history cannot be obtained. In particular, the time of the ingestion and the type of object ingested is frequently impossible to determine prospectively. Occasionally the radiologist is the first clinician to discover an ingested foreign body. Even older children are reticent about or unable to discuss the specifics of the ingestion.

Fig. 3 Complications during further hospital course. Shown are abscesses (arrows) in the pelvis (a) and spleen (b)



Most foreign body ingestions are inert objects, which will pass spontaneously from the gastrointestinal tract. Occasionally ingested foreign bodies may become stuck in the esophagus or stomach, requiring endoscopic or fluoroscopic removal. Recently, however, there have been several case reports of highly morbid and potentially lethal ingestions involving magnets. The Center for Disease Control (CDC) recently issued a review of magnet ingestion cases for the period 2003–2006 [4]. The CDC reports 20 cases of magnet ingestions with gastrointestinal injuries in the past 3 years. Complications caused by the magnet ingestions included bowel perforation in 16 of the 20 cases; other major complications included volvulus leading to necrosis and sepsis in two cases, whereas in the remaining two cases there were only mild complications such as superficial ulcerations of the gastric mucosa. One case resulted in death while the other 19 required surgery. Patients ranged in age from 10 months to 11 years, with a mean age of about 6 years. Four of the ten patients over 5 years of age had potentially relevant conditions, such as neurological disorders and attention-deficit/hyperactivity disorder. Recommendations from the CDC are for caregivers to keep magnets away from unsupervised children and to seek immediate attention for magnet ingestions.

The magnetic compression of two adjacent bowel loops can cause pressure necrosis, with eventual perforation and fistula formation. This process, in fact, is used as a surgical technique in which magnets are used intentionally to form holes in the walls of visceral or vessel structures to create anastomoses between the bowel and the bile system as well as between vascular structures [5, 6].

The radiographic appearance of multiple magnet ingestions or a single magnet with other metallic objects may be subtle or impossible to discern, depending on the angle at which an object or objects is imaged. If a patient presents with unwitnessed metallic foreign body ingestion with or without abdominal symptoms, clinical suspicion of magnet ingestion should be raised. Additional radiographs or fluoroscopy at oblique angles may help to discern whether the metallic foreign body is truly a single object or the unification of multiple attracting metallic and magnetic objects. Subtle separations or gaps between otherwise individual metallic pieces can suggest the presence of bowel wall between magnets and/or other metallic foreign bodies, although the absence of any gaps within the object certainly does not exclude the fact that it may consist of

multiple attached objects. If unrecognized initially, the absence of movement of the metallic foreign body on a follow-up radiograph should also raise the suspicion of magnetic foreign bodies entrapping bowel. When radiographic signs of small bowel obstruction are suspected, bowel perforation may have already occurred. Free air is the identifiable radiographic sign of severe complications of magnet ingestion. The surgical and radiological literature supports early surgical intervention in cases of suspected ingestion of multiple magnets or multiple metallic and magnetic foreign bodies [7].

Although foreign body ingestion is relatively common in children, each type of ingested foreign body carries its own potential risks to the patient. Some foreign bodies have a relatively large diameter and may become lodged in the esophagus, while some have sharp edges, which have the potential to cause hollow visceral injury, and still some ingested foreign bodies such as small batteries have the potential for injury related to the toxic contents. All pediatric health-care providers should be cognizant of the potential dangers of multiple magnet ingestion as detailed above and should be able to suggest early and rapid radiological evaluation. All radiologists should be cognizant of the potential dangers of magnet ingestion and the potential radiographic appearances, and should be able to suggest early enterotomy to surgeons to avoid significant consequences.

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