

Multiple Magnet Ingestion as a Source of Severe Gastrointestinal Complications Requiring Surgical Intervention

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Objective: To raise awareness of the dangers associated with magnet ingestion in children.

Design: Case report and review of the literature.

Setting: Tertiary care children's hospital.

Patient: Four-year-old boy with minimal physical findings but with a clinical history and imaging suggesting complications from multiple magnet ingestion.

Intervention: Laparoscopic removal of magnets and repair of magnet-induced enterotomies.

Outcome Measure: Clinical course.

Results: Full recovery after surgical intervention.

Conclusions: Ingestion of multiple magnets can cause minimal initial physical examination findings but result in significant complications, including bowel perforation, volvulus, ischemia, and death. Early surgical intervention can prevent significant morbidity and mortality. Clinical vigilance should be exercised in these cases and early surgical consultation with an aggressive surgical approach is recommended. Parents should be warned against the dangers of children's toys that contain these powerful magnets.

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FOREIGN BODY INGESTION IS common among children.^{1,2} The gastrointestinal (GI) tract is remarkably resilient to the passage of a wide range of nonfood objects. Surgical intervention is generally required if an object becomes lodged in the GI tract (most commonly at the lower esophageal sphincter, pylorus, or ileocecal valve) or if the material has harmful effects, such as the corrosive effect of batteries.^{3,4} Even in the case of battery ingestion, most batteries will pass and selective surgical management can be employed based on symptomatology.³

Cases of magnet ingestion with significant morbidity have been described in the surgical,⁵⁻⁷ family practice,² emergency medicine,⁴ and gastroenterology^{1,8} literature and in a review of 20 cases issued by the Centers for Disease Control and Prevention,⁹ but the problem has not been adequately addressed in the general pediatric literature. With this report, we hope to alert pediatricians and pediatric surgeons to the dangerous nature of this seemingly benign occurrence and urge aggressive treatment in these patients to avoid serious sequelae. Finally, we hope to alert the public to the dangers of children's toys that contain small detachable magnets.

PATIENT REPORT

The parents of an otherwise healthy 4-year-old boy witnessed him swallowing a small tablet-shaped magnetic piece from a toy set (**Figure 1**). On the following day his parents witnessed him swallow another, identical magnet. His parents initially assumed that the magnets would pass in his stool. However, after 72 hours, the child began to develop mild, dull left-sided abdominal pain, which prompted a visit to the emergency department. He exhibited no vomiting, abdominal distention, or diarrhea.

On examination by the emergency department physician, the child was afebrile, denied any abdominal pain, and was in no apparent distress. Vital signs were within normal limits. An abdominal radiograph was obtained (**Figure 2A**) and showed an obvious opacity in the right lower quadrant area of the cecum consistent with the 2 magnets adhering to one another. Laboratory investigation results were unremarkable, including normal white blood cell and differential cell counts. However, the presence of abdominal pain prompted a surgical consultation.

Examination by the surgeon revealed a reproducible, mild localized tenderness in the right lower quadrant without signs of peritonitis. Because of a high degree of suspicion of the potential complications of magnet in-

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Figure 1. Magnets embedded in a plastic piece (right) from a toy set can easily detach and are small enough to be swallowed by a child.

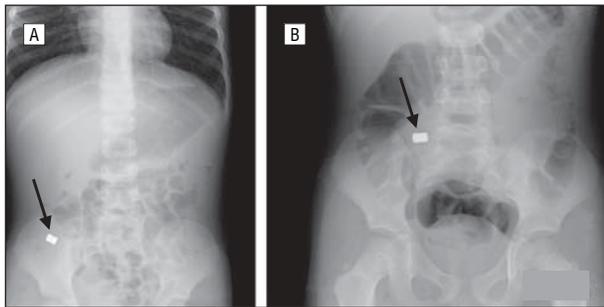


Figure 2. Abdominal radiographs taken at presentation show what appears to be the 2 magnets stuck together in the cecum (A, arrow) and at 5 hours later when the magnets have not shifted upward as would be expected if in the cecum (B, arrow).

gestion in addition to the abdominal tenderness, the surgeon recommended exploratory laparoscopy. However, because both magnets appeared to be in the cecum, the parents requested a period of observation and another abdominal radiograph. Radiography was performed 5 hours later and showed migration of the objects medially rather than superiorly (Figure 2B), as would be expected if they were in the right colon. A plan for immediate surgical exploration was then instituted.

SURGICAL FINDINGS AND TREATMENT

Laparoscopy using a 3-port approach revealed a loop of terminal ileum closely adherent to the midright colon with omental walling of the area. Removal of the omentum revealed an acute fistula between the 2 pieces of bowel (**Figure 3**) in which the 2 attached magnets were situated. This corresponded with areas of perforation from pressure necrosis on each bowel wall caused by the magnetic attraction. The magnets were then easily delivered from the enterotomies (**Figure 4**), as they attached firmly

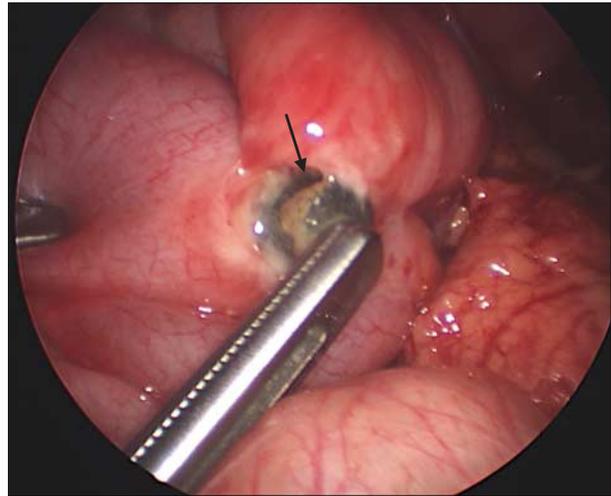


Figure 3. Removing the adherent omentum revealed where the magnets (arrow) had eroded through the bowel walls.

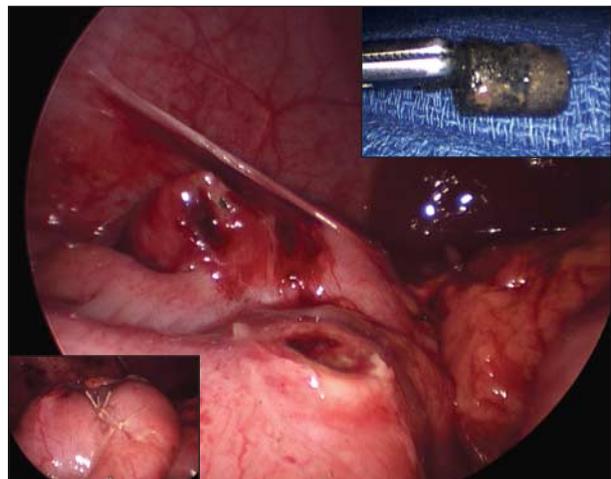


Figure 4. The magnets (upper inset) were attracted to the laparoscopic instruments and were easily removed from the belly, leaving 2 enterotomies that were repaired laparoscopically (lower inset).

to the metallic ends of the laparoscopic instruments, and the bowel was repaired primarily using laparoscopic intracorporeal suturing techniques. He received perioperative broad-spectrum antibiotics (cefotaxime) for one preoperative dose and for 24 hours following operation.

POSTOPERATIVE COURSE

The child resumed bowel function in 24 hours and was tolerating a full diet within 48 hours. He was discharged to home on postoperative day 3 and remained well at 1 month follow-up.

COMMENT

The ingestion of magnets represents a unique circumstance. In isolation, a single magnet is typically innocuous and is expected to behave much like other foreign bodies. On the other hand, the ingestion of multiple magnets or concurrent ingestion with a metallic object can convert a clinically benign situation into a potentially serious one.

As small and powerful rare-earth magnets are used increasingly in children's toys, pediatricians and pediatric surgeons are more likely to encounter this scenario. It is important that pediatric care providers are made aware of the serious consequences of magnet ingestion and that they are distinct from most other types of foreign body ingestion.

A Centers for Disease Control and Prevention report identified 1 death and 19 cases of GI damage requiring surgical intervention owing to magnet ingestion.⁹ Fifteen of the cases resulted in bowel perforation, with bowel obstruction and peritonitis in 4 patients, and 1 fatality caused by volvulus, bowel necrosis, and sepsis. In a recent report of a 4-year-old girl who ingested 4 small magnets, İlçe et al¹⁰ found intestinal volvulus and perforation secondary to pressure necrosis. They recommended that emergent surgery be undertaken in patients who have ingested multiple magnets who have signs of intestinal obstruction.

A case presented by Nagaraj and Sunil⁵ elucidates how a magnet ingested with objects attracted to the magnetic field can also pose danger. They describe a 10-year-old boy who ingested an alkaline disk battery, a magnet, and a steel ball. On examination, he was found to have peritoneal signs and on laparotomy, the magnet and steel ball were attracted to one another forming a single unit, with the disk battery and magnet attracted across a loop of ileum, causing necrosis and perforation. Another report, by Hernández Anselmi and colleagues,⁶ describes an ileocecal fistula caused by the ingestion of 2 small magnets. In contrast with our case, this patient was febrile with clear findings of peritonitis, which instigated operative intervention.

In our case, the ingestion of the 2 magnets was concerning because they occurred on 2 separate days. If occurring at the same time, it is likely that the magnets could have attached in the stomach and passed simultaneously. This also applies to the ingestion of a magnet and any object attracted to the magnetic field. With any significant interval between ingestions, there should be a high concern for portions of the GI tract being squeezed between the magnets. Although the initial abdominal radiograph actually made it appear as if the magnets were attached to each other, the critical clue was that, through serial radiography, the magnets did not travel from the cecum through the expected path (up the ascending colon), but rather they shifted medially. Therefore, we suspected that the magnets were tightly apposed, with a piece of the intestinal wall interposed, which formed the basis of our decision to operate. This case was also alarming because of the relatively minor physical and laboratory findings despite serious bowel complications. The clinician examining such a patient should have a high degree of suspicion.

The type of bowel injury varies with multiple magnet ingestion and includes obstruction, volvulus, or perforation. If 2 loops of the bowel are fixed in place by the magnets, a kink in the bowel can occur, resulting in obstruction. Similarly, this area of fixation can act as a point of volvulus, leading to subsequent bowel necrosis, sepsis, and (as in 1 case⁹) death. The pressure placed on the intervening GI tract by 2 magnets can be strong enough to cause necrosis and perforation. In our case, a fistula developed between the cecum and terminal ileum. If left alone, these walled-off adjacent perforations would likely form a se-

cure fistula, and the magnets, once fully attached, would likely be expelled. While an ileocecal fistula is unlikely to be symptomatic, a fistula between widely spaced portions of the GI tract would have significant long-term morbidity, and it cannot be assumed that a benign fistula would result.

Pressure necrosis and fistula formation can be a gradual process and, in older children, omental walling can limit peritoneal inflammation resulting in minimal physical examination findings. Therefore, the absence of significant signs and symptoms of intestinal damage should not preclude aggressive management. In children 3 years and younger, the relatively fat devoid omentum may be less effective at containing perforation and such a child would be expected to have a more advanced presentation.

We are particularly concerned that these powerful magnets are widely available in popular children's toys. In many of the toys, the magnets are embedded in plastic parts, though they become easily detached (Figure 1). Parents should be alerted to the dangers of these toys, particularly in small children.

Multiple magnet ingestion is a unique form of foreign body ingestion that should be treated expeditiously and aggressively despite relatively minor findings. Complications may include severe bowel injury and possibly death. If treated early, a fast recovery and good surgical outcome can be expected. Pediatric specialists should take a vigilant approach to this problem and seek early surgical consultation.

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