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CASE REPORT

Gastroenterology

Successful endoscopic removal of high-power magnetic balls embedded in the duodenal wall

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Abstract

The dangers of magnet ingestion are well known. When multiple magnets are ingested, interventional removal is often necessary to prevent and/or treat complications. Despite reports of both endoscopic and surgical techniques in the literature, there is a lack of clear guidance on the best method for removal of high-power magnets when they are embedded within the intestinal wall (increasing concern for fistulation, perforation, and bowel wall necrosis). This case demonstrates the successful endoscopic removal of magnetic balls incidentally identified on X-ray and found to be embedded in the duodenal wall in a critically ill 2-year-old patient. Endoscopic removal can be considered in similar situations, if all resources (interventional endoscopy and pediatric surgery) are available to proceed safely.

KEYWORDS

endoscopy, foreign body, magnets, pediatric ingestion

1 | INTRODUCTION

Powerful rare-earth neodymium magnets (i.e., buckyballs) are notably more dangerous than other magnets when ingested due to their increased magnetic pull.[1] Despite packaging in the United States indicating that magnetic balls are for those ≥14-years-old, younger children are more likely to ingest the hazardous magnets with US studies reporting a mean age of 5.2–7.6 years-old.[2,3] Morbidity associated with ingestion is more likely in younger children.[2]

The longer magnets have been in the gastrointestinal tract, the more likely they are to cause complications such as enteroenteric fistulation, perforation, and bowel wall necrosis. Despite the increased risk for complications with increased time from ingestion to identification, patients may remain asymptomatic.[4,5]

The North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN) guidelines state that if endoscopic removal is possible, based on magnet location, esophagogastroduodenoscopy (EGD) or colonoscopy should be performed.[6] Magnets in more difficult to reach locations may require surgical intervention.[6]

Clear guidance is lacking on the management of magnets that have embedded within the bowel wall for an unknown period of time. This case demonstrates the successful endoscopic removal of postpyloric magnetic balls embedded in the duodenal mucosa.

2 | CASE

A 2-year-old male was hospitalized for acute respiratory failure requiring mechanical ventilation and extracorporeal membrane oxygenation (ECMO). At the time of presentation, four respiratory pathogens were isolated on his respiratory viral PCR panel that were thought to be the main drivers of his critical clinical status. As part of his initial evaluation an X-ray was performed, which incidentally identified 16 round radiopaque balls connected in a circular formation, without signs of bowel obstruction nor perforation (Figure 1A). The balls were suspicious for high-power

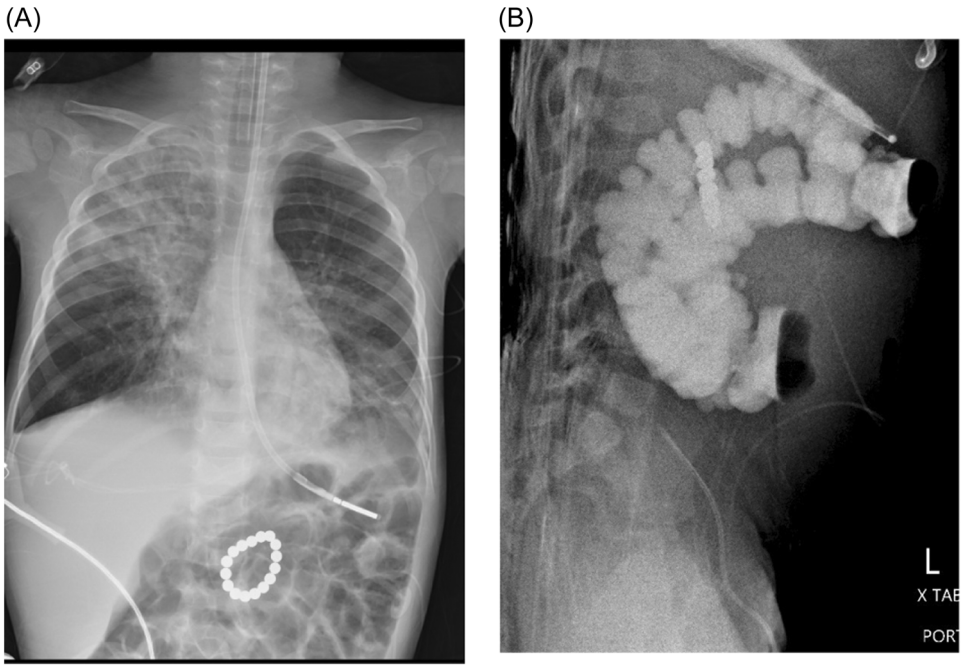

FIGURE 1 X-Ray images: (A) chest and abdomen- anteroposterior view. (B) abdomen- lateral view with enteral contrast.

magnetic balls. A gap between 2 of the balls increased concern for bowel wall compression. However, the patient had no abdominal complaints on presentation and the patient's parents were unaware of a foreign body ingestion.

The patient's respiratory status was critical. Endoscopic evaluation and cross-sectional imaging were not initially possible due to escalating respiratory support. A portable lateral X-ray with enteral contrast was obtained bedside and indicated a retroperitoneal location of the balls, likely in the duodenum (Figure 1B). There was no extravasation of contrast from the intestinal lumen.

On Hospital Day 7, the patient remained on ECMO, but was deemed stable for bedside endoscopic evaluation. Our team wanted to confirm if the balls were indeed magnets and to evaluate whether their presence within the abdomen may have contributed to the patient's rapidly worsening clinical status. An ultraslim gastroscope was used to visualize multiple colored metallic round balls in the second portion of the duodenum, consistent with high-power magnetic balls. The surrounding duodenal wall itself appeared normal, without significant edema, bleeding, or ulceration. We did not attempt removal at this time as the potential risk of complications from removal outweighed the risk of leaving the magnets in place, which had been stable on serial imaging for 1 week without surrounding mucosal damage.

Over subsequent days, multidisciplinary discussions occurred on how to remove the magnetic balls. The patient's abdominal exam remained unchanged. As his respiratory status gradually improved, he was taken off ECMO, but remained intubated. On Hospital Day 17 a multidisciplinary decision was made for removal to be attempted by the interventional endoscopy team. He was nearing extubation and we wanted to avoid the need for reintubation for a procedure in the future. Pediatric surgery was present for the entire procedure. Multiple metallic balls were again identified in the second portion of the duodenum and confirmed to have magnetic attraction. The balls linked single file in a curvilinear formation along the medial duodenal wall (Figure 2A). They were removed in segments (1-5 ball increments) using rat tooth forceps and a Roth Net®. The rat tooth forceps provided a firm grasp around the magnets to overcome the magnetic attraction. As the magnetic balls were separated, they were either removed with the forceps or collected using the Roth Net®.

Most magnets were removed without difficulty, but the last 2 were not visualized (beyond the blue ball in Figure 2B). The proximal ball was grasped with the rat tooth forceps and traction was applied (Supporting Information: Video). The distal balls remained magnetically attached and were pulled from the duodenal wall (Figure 2C). The removal of the last few balls revealed a small duodenal wall defect that was closed with one endoscopic clip (Figure 2D).

Following clip placement, contrast was administered under fluoroscopy with no evidence of extravasation nor additional magnets. The patient recovered without complication and tolerated enteral feeds. He was discharged to a rehabilitation facility on Hospital Day 53.

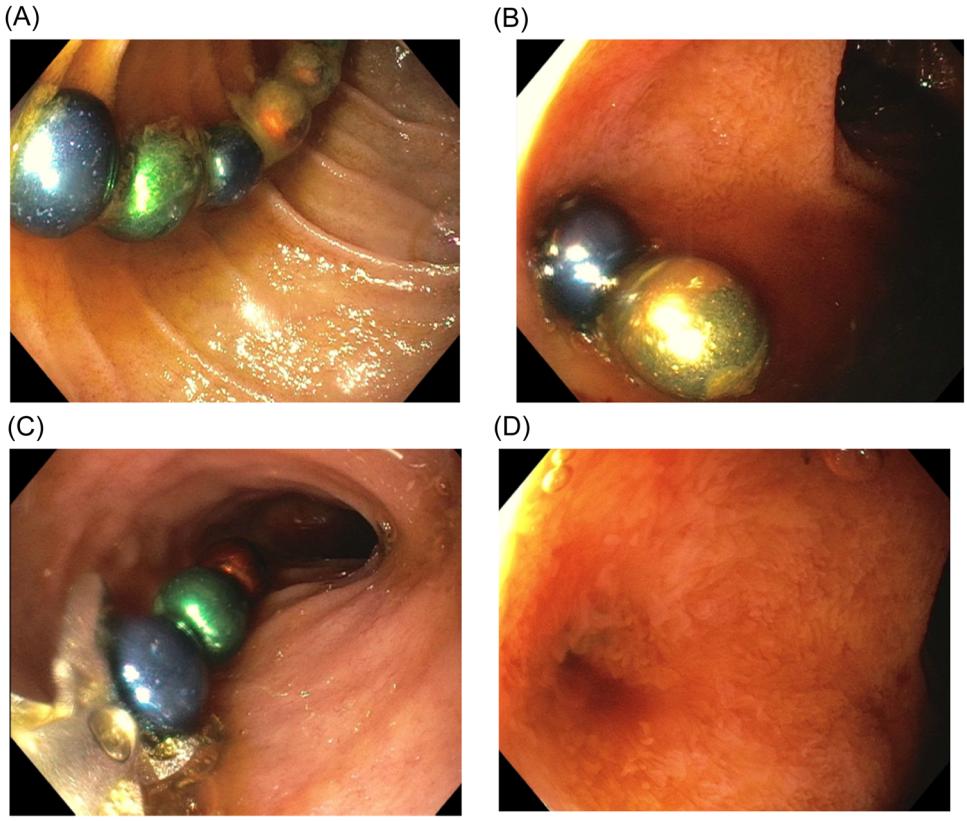

FIGURE 2 Endoscopic removal: (A) magnetic balls in the second portion of the duodenum. (B) Distal magnetic balls embedded within the duodenal wall. (C) Removal of embedded magnetic balls with rat tooth forceps. (D) Mucosal defect in the duodenal wall.

3 | DISCUSSION

Prior studies have reported on endoscopic and surgical techniques for removal of multiple magnets.[1,7] The NASPGHAN guidelines are helpful in determining the optimal intervention for removal of magnets based on location, but they do not provide guidance on how to approach magnets that have embedded in the bowel wall. While endoscopic intervention is less invasive than surgical techniques, it is typically reserved for easy to reach locations without associated bowel wall complications.

Surgical intervention is associated with increased morbidity and mortality, but unfortunately, is often necessary. A 2013 study found that almost 70% of children (age ≤15-years-old) who ingested rare-earth magnets required surgical removal.[8] Patients who require a surgical approach, such as a laparotomy, increase their risk for future complications. One study found that those who undergo laparotomy carry a 4.6% lifetime risk of adhesive bowel obstruction.[9]

In a more recent study, 14/99 children who ingested multiple magnets, required surgical removal. Endoscopic removal was attempted in 3 of the 14 cases before surgery, but was unsuccessful due to mucosal injury and incomplete visualization of the magnets.[10] There is a paucity of data on how to approach the ingestion of multiple magnets when there is incomplete visualization of the magnets or when there is mucosal injury (in the absence of an obvious surgical indication such as bowel perforation).

Because there is a lack of data on how to approach magnets embedded in the duodenal wall that have been in place for an unknown period of time, our team utilized multidisciplinary decision-making. We took into account the increased risk of morbidity and mortality of surgery, especially in our already critically ill patient, and additionally considered that the retroperitoneal position of the magnets would be difficult to access surgically. For these reasons, and because our patient was asymptomatic, without signs of bowel wall complications, we opted for endoscopic intervention with surgical backup. Fortunately, our patient did not require surgical care.

There is a need for future research to discuss and evaluate approaches to foreign body removal, especially hazardous objects such as magnets, beyond the basis of location within the enteral tract. These cases are often situation, patient, and institution dependent, but when reported in the literature they enhance the ability of other providers to have successful outcomes.

This case reports the successful endoscopic removal of multiple magnets embedded within the duodenal wall, with an endoscopic clip repair of the

mucosal wall defect. Endoscopic intervention should be considered if all resources, including interventional endoscopy and pediatric surgeons, are available.

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CONFLICT OF INTEREST STATEMENT

Dr. Kumta: Consultant for Apollo Endosurgery, Boston Scientific, SafeHeal, Olympus. The remaining authors declare no conflict of interest.

ETHICS STATEMENT

Informed patient consent was obtained for publication of the case details and photographs included.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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