



Case report

Multiple magnet ingestion causing intestinal obstruction and entero-enteric fistula: Which imaging modality besides radiographs? A case report

Evangelos Blevrakis^{a,*}, Maria Raissaki^b, Sofia Xenaki^a, Elissavet Astyrakaki^c, Nelli Kholcheva^b, Emmanuel Chrysos^a

^a Dept of Pediatric Surgery. University Hospital of Heraklion, Crete, Greece

^b Dept of Radiology. University Hospital of Heraklion, Crete, Greece

^c Dept of Anesthesiology. University Hospital of Heraklion, Crete, Greece

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ABSTRACT

Ingested foreign bodies occur in children younger than 3 years and pass uneventfully through the gastrointestinal tract. However, multiple magnet ingestion are associated with serious complications. A 9-year old male with abdominal pain and vomiting 3 days prior to admission, underwent abdominal radiographs showing radiopaque foreign bodies. Ultrasonography (US) independently discovered one magnet floating in the jejunum. Preoperative Computed Tomography (CT) confirmed the presence of two neighbouring magnets causing obstruction and beaking of an adjacent jejunal loop. Laparotomy led to uneventful recovery of transmesenteric fistula formation following pressure necrosis in two jejunal loops. We present the first case of multiple magnet ingestion managed in our institution, where the prevalence of magnet ingestions is low due to unpopularity of magnet toys. **Conclusion:** Awareness of the potentially devastating effects of multiple magnets passing the pylorus and the contribution of different imaging modalities for the diagnosis are emphasized and discussed.

1. Introduction

Foreign body ingestion is a potentially serious problem that peaks in children aged six months to three years, however only 1% of cases require operative management of associated complications [1] [21]. Because many patients who have swallowed foreign bodies are asymptomatic, physicians must maintain a high index of suspicion for the possibility of multiple magnet ingestion, a condition that invariably requires some form of intervention and may ultimately lead to laparotomy [2,3]. The risk associated with magnet ingestion by children has been emphasized in the literature and its incidence is not negligible due to the commercial availability of magnets in toys, especially in some European countries and in the US [4,5]. In our country magnet toys are not very popular, therefore this condition is rarely encountered. Proposed management algorithms for magnet ingestion in children are based on clinical circumstances and the presence of non-advancing radiopaque magnets in serial abdominal radiographs [4,6].

We report the first case of enteroenteric fistula and consequent small bowel obstruction due to two ingested magnets treated in our Department, emphasize awareness of the hazardous condition associated with multiple magnet ingestion and discuss the complementary

role of serial AP/lateral radiographs, US and CT in decision making.

2. Case report

A 9-year-old boy was admitted to our hospital in the pediatric ward, with a 3 days history of vomiting and abdominal pain. On admission his abdomen was tender and distended and the laboratory values were within normal limits. An abdominal x-ray showed clearly signs of proximal obstruction and a bi-lobed radio-opaque foreign body at the right mid-abdomen (Fig. 1). The family did not report anything unusual, however the child recalled that ten days ago he ingested two spherical magnetic balls of the size typically seen in magnet sets, during playing.

The child was admitted for observation and underwent an ultrasound scan of the abdomen 1 day later, that showed small bowel dilatation with lack of peristalsis and the presence of an echogenic intraluminal focus looking like a stone, moving inside a bowel loop, consistent with an ingested foreign body. Bowel wall thickening and free fluid were also present (Fig. 2). It was not possible to say by ultrasonography whether there was an additional foreign body located elsewhere or whether the two magnets were stuck against each other. Repeat abdominal radiographs up to 72 hours later, with the child being

Abbreviations: AP, anteroposterior; CT, Computed Tomography; FBI, Federal Body Investigation; US, Ultra Sonography

* Corresponding author.

E-mail address: sofiabecks@yahoo.gr (E. Blevrakis).

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Fig. 1. Abdominal radiograph on admission showing a radiopaque foreign body without completely rounded margins, exhibiting an hourglass shape, consistent with two magnets in close proximity (arrow). Air-filled jejunal loops with air-fluid levels (arrowhead) with paucity of bowel gas distally, suggest early obstruction.

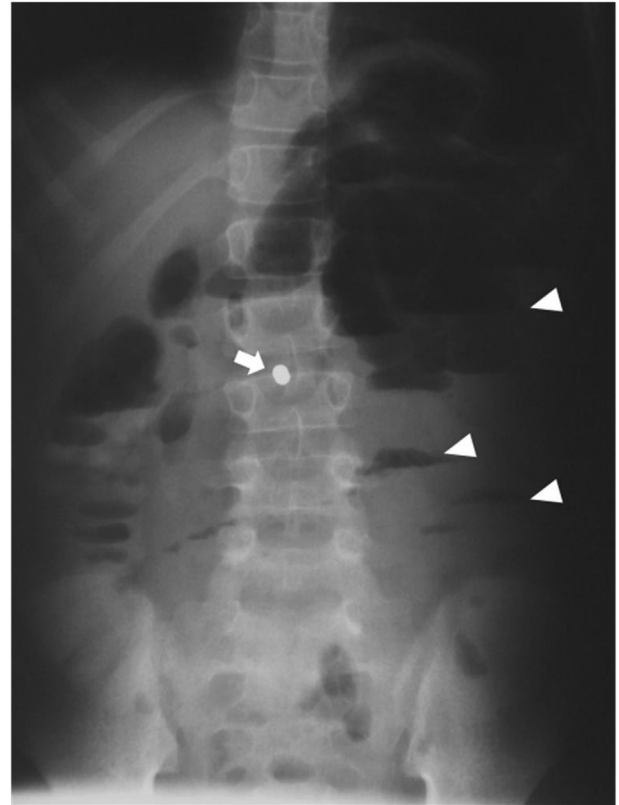


Fig. 3. Follow-up abdominal radiograph showing slight movement of the radiopaque foreign body (arrow) without significant progression into the ileum. Note established small bowel obstruction with multiplication of air-filled jejunal and ileal loops containing air-fluid levels (arrowheads) and persistent paucity of bowel gas distally.

in a good general condition, showed lack of foreign body progression (Fig. 3), persisting pain and the patient was referred to the Surgical ward of our Hospital with a nasogastric catheter in place. Laboratory values remained within normal limits, there was no improvement of abdominal distension, pain recurred and became continuous. Surgery

was planned and a CT scan was performed preoperatively. On the lateral scout view the two magnets were closely opposed to each other (Fig. 4). Magnets casted a large star-like artefact, hampering the visualization of adjacent structures (Fig. 5). Small bowel obstruction without a definite point of transitions but with beaking of adjacent loops was noted, in relative vicinity with the metallic foreign bodies

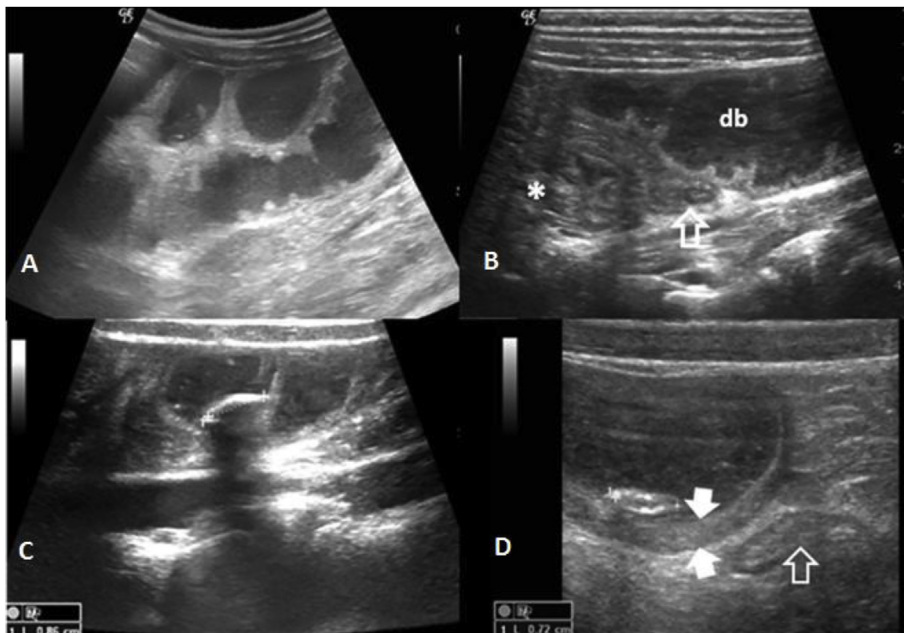


Fig. 2. Ultrasonography requested for non-specific abdominal pain.

A. Longitudinal scan through the left upper abdomen showing fluid-filled, distended bowel loops without any peristalsis.

B. Longitudinal scan at the right iliac fossa showing a distended ileal loop (db), the mucous pattern of collapsed bowel (*) and a normal appendix (arrow).

C. Longitudinal scan at the epigastrium showing an echogenic intraluminal foreign body (between cursors) casting an acoustic shadow (arrow). The loop containing the “stone-like” lesion, is anterior to the aorta (Ao).

D. Repeated scan of the area 10 minutes later with the patient standing showed that the foreign body had dislodged in another distended loop with a thickened wall (open arrow). Note an adjacent normal loop (white arrow).



Fig. 4. Scout prior to scanning. A. AP view and B. Lateral scout view of the abdomen. It is better appreciated on the lateral scout that there are two separate metallic objects (within circles) closely situated in the abdominal cavity, behind or inside the dilated small bowel loops (arrows).

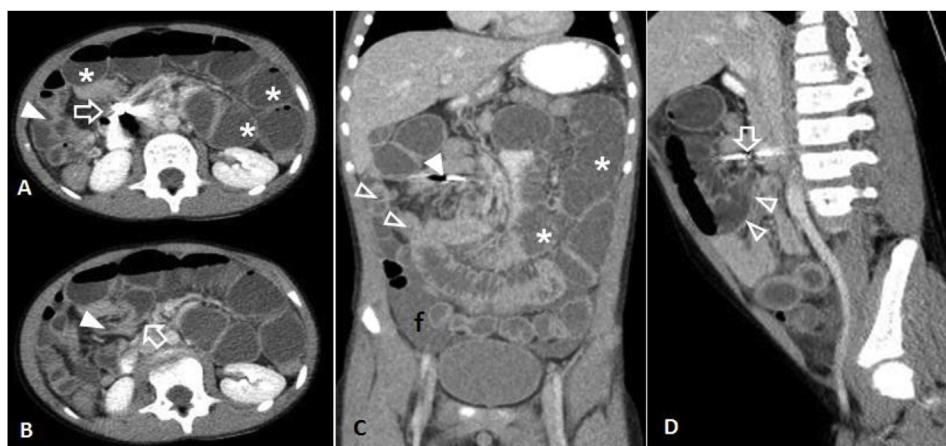


Fig. 5. CT of the abdomen. A. Axial scan through the upper abdomen shows the metallic magnets casting a large “star” artefact (arrow). Note distended small bowel loops (*) to the left and collapsed small bowel to the right (arrow-head). B. Axial scan just caudally to A, shows beaking of the small bowel (arrow) towards the magnets and transition to a non-distended loop (arrowhead). C. Coronal scan showed proximal dilatation (*), collapsed loops (open arrowheads) distally to the magnet-related artefact (arrowhead) and free fluid (f). D. Oblique reconstructed image showing the ascending course of the afferent loop (arrowheads) towards the magnet (arrow).

(Fig. 5). Enhancing mesenteric thickening and free fluid were also observed (Fig. 5). Small bowel obstruction secondary to the ingested magnetic balls was diagnosed and laparotomy was performed.

Upon exploration, at 20cm distal to the ligament of Treitz, two proximal ileal loops were seen to adhere to each other at their anti-mesenteric borders with interposed red mesentery containing a thin and short transmesenteric-entero-enteric fistula. The two small magnets were found on both openings at the margins of the fistula. The fistula was resected and the anti-mesenteric borders of the two ileal loops were repaired with sutures (Fig. 6). The patient had an uneventful post-operative course and he left the hospital in a good general condition two weeks later.

3. Discussion

Foreign Body Ingestion (FBI) in young children is one of the most

common causes for presentations to emergency departments. It is estimated that 40% of these ingestions may go unnoticed [7]. Seventy percent of all FBI occur in children comparing to the 30% in adults yet only 1% of cases will require operative management of associated complications [8,9]. Intervention is most often required in cases of aspiration into the airway, of impaction within the esophagus, of aspirated or ingested battery button due to the caustic injury from high pH, of ingested multiple magnets causing pressure necrosis, of long or sharp ingested foreign bodies causing intestinal wall trauma, partial or complete obstruction, perforation and leading to life threatening situations [6,8,9].

Multiple magnet ingestions are known to be associated with complications and potentially devastating results [10,11]. Deaths due to resulting peritonitis have also been reported [12,13]. A 2-year old child's death eleven years ago by magnets' ingestion in Washington DC brought to the surface greater attention concerning the problem of FBI

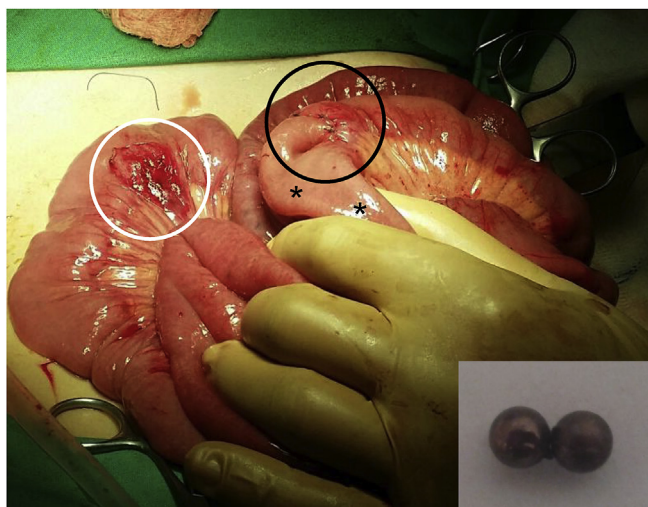


Fig. 6. Photograph during operation shows the hole in the mesenteric border of a jejunal loop with redness of the adjacent mesentery and serosa (within white circle), the repaired hole in another jejunal loop where the magnets were extracted from (with sutures inside black circle) and the non-dilated small bowel distally (*). The two magnets are seen following extraction, in the embedded image (bottom right).

[12,13]. The risk associated with magnet ingestion has been exacerbated by the commercial availability of newly engineered magnets containing iron, boron, and neodymium that are 5–10 times stronger compared to traditional iron magnets [14,15]. The United States Consumer Products Safety Commission in December 2012 acknowledged this disturbing trend by issuing proposed safety standards for small, high-powered magnets, based on the “unreasonable risk of injury associated with children ingesting high-powered magnets that are part of magnet toy sets.” [16] Although most magnets are small and can easily pass through the intestinal tract, upon magnetic approximation (when more than one are ingested), a considerable amount of force can be produced resulting in an inseparable magnetic attraction between bowel loops [8,14,15]. When clinically underestimated, attracted magnets belonging into different bowel loops cause pressure necrosis of the intervening tissue which will eventually lead to perforation and/or enteroenteric fistula formation in up to 91% of reported cases [8,14,15]. The severity of injuries caused by magnet ingestion has increased since 2009 with more ingestions requiring emergency surgery or hospitalization [15]. This is the first case of multiple magnet ingestion managed in our Institution, in a 9-year-old tourist visiting our country from another European country. We were not familiar with the condition due to relative unpopularity of magnet toys in our area. Delay of surgery in children with multiple magnet ingestion has been reported [17], mainly due to the stable clinical condition of the patient, such as in our case and due to the hope of spontaneous passage of the foreign bodies, occasionally with the aid of laxatives which was the case during hospitalization of our patient in the pediatric ward.

In order to minimize complications, early intervention should be ensured by a good medical history [8,15]. When two or more magnets have been ingested, prompt evaluation, imaging, and consultation with gastroenterologists or surgeons are warranted. Most of the magnets are visible radiographically since these objects are radio-opaque as published in previous reports in the literature [10,14,15,18,19]. Stacked magnets can simulate a single magnet on plain radiography. The presence of deep symmetric indentations or a traversing lucent line in the silhouette of the radiopaque foreign body is indicative of more than one ingested magnets. In case it is not clear whether there are one or two, a lateral radiograph may prove useful, such as in our case. Accompanying signs of complicated foreign body ingestions in the abdominal X-ray include dilated intestinal loops with air/fluid levels in erect radiographs

and occasionally pneumoperitoneum from perforation [8,18,19].

Ultrasonography may be the first imaging test performed in a child with abdominal complaints and may demonstrate the presence of the magnet intraluminally, mimicking a floating stone, as well as evidence of fluid-filled dilated bowel loops due to obstruction. In such cases the examiner should carefully inspect adjacent bowel loops for a second magnet and the adjacent mesentery for the presence of surrounding echogenicity. In cases of suspicious US findings, a radiograph should then be performed, even in the event of a lacking history.

In our case the decision for laparotomy was based on the history, lack of progression of the radiopaque foreign bodies and persisting abdominal complaints. CT was requested for preoperative evaluation of the situation, confirmed the presence of two magnets closely to the point of transition between dilated and non-dilated small bowel, thus providing findings consistent with a surgical abdomen. The presence of the fistula could not be diagnosed preoperatively with confidence, due to multiple artefacts at the vicinity of the magnets, however it was suggested by the finding of beaking of adjacent loops, a findings that is also encountered in adhesions and close loop obstruction. CT could be avoided when there is a definite history and a positive radiograph, since it appears to not add any information that may alter the decision for or the type of surgery. However, CT may prove useful in unsuspected cases of children without an appropriate history and without an available radiograph.

MRI is increasingly performed in children with abdominal complaints, following an equivocal ultrasound scan, in many centers. However, MRI is contraindicated in children with ingested metallic objects to avoid more damage due to movement or heating of the object inside the abdomen [20]. Therefore MRI should never be performed without a negative radiograph or when there is such a history.

Children with single magnet ingestion should be advised to avoid clothing with metallic buckles, zippers, or studs until the magnet passes through the gastrointestinal tract. A single magnet coupled with 1 or more metallic objects is equally injurious as multiple magnets. Clinicians caring for children and teens need to specifically inquire about multiple magnet ingestions with or without metallic objects ingestion when evaluating children with abdominal complaints. Large magnets stuck together are capable of causing mechanical symptoms based on size alone, such as obstruction or volvulus. Failure of progression through the intestine on sequential radiographs should trigger surgical or endoscopic evaluation. Gaps between magnets or between magnets and metal foreign bodies should raise the possibility of entrapment and ischemic damage to interposed bowel wall [10,15,19].

This case report highlights the need for awareness of the injurious effects of multiple magnet ingestion in children requiring close observation and early surgical intervention. Appropriate history and a positive radiograph should suffice for the diagnosis and management. In equivocal results, lateral abdominal views and serial radiographs are indicated. Ultrasonography might not be able to demonstrate the presence of multiple magnets and CT should not be routinely performed in these children, however they may prove useful in cases there is no appropriate history provided and no available radiograph.

Ethical approval

All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Author contribution

Evangelos Blevrakis was the leading surgeon and contributed in the narration of the manuscript and the creation of the figures.

Maria Raissaki was the specialized radiologist and contributed in the diagnosis of the case and the creation of the figures.

Sofia Xenaki assisted in the operation and contributed in the narration of the manuscripts.

Nelli Kholcheva contributed in the radiological diagnosis of the case.

Elissavet Astyrakaki was the specialized anesthesiologist.

Emmanuel Chrysos the leader of the team and the head of the department.

Conflicts of interest

Evangelos Blevrakis: declares that there is no conflict of interest.

Maria Raissaki: declares that there is no conflict of interest.

Sofia Xenaki: declares that there is no conflict of interest.

Nelli Kholcheva: declares that there is no conflict of interest.

Elissavet Astyrakaki: declares that there is no conflict of interest.

Emmanuel Chrysos: declares that there is no conflict of interest.

Research registration number

None.

Guarantor

Prof Emmanuel Chrysos MD FACS.

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