



Unusual Cause of Complex Enteroenteric Fistulae in Children: A Warning Letter to the Parents

**Mohamad Daboos¹, Mohamed Mahfouz¹, Dalia Gad², Mabrouk Akl¹,
Mohamed El-Sayed¹, Omar Alsamahy², Medhat Ibrahim¹, Riadh
BenMalek³, Gamal Al-Saied^{1,3*} and Mohamed Negm⁴**

¹College of Medicine, Al-Azhar University, Cairo, Egypt

²College of Medicine for Girls, Al-Azhar University, Cairo, Egypt

³King Faisal Medical Complex, KSA

⁴Qena Faculty of Medicine, South Valley University, Qena, Egypt

***Corresponding Author:** Gamal Al-Saied, College of Medicine, Al-Azhar University, Cairo, Egypt.

Received: June 08, 2022

Published: June 28, 2022

© All rights are reserved by **Gamal Al-Saied, et al.**

Abstract

Background: Foreign body (FB) ingestion is a common problem in infants and children. Most of them pass spontaneously via gastrointestinal tract. Some of them are potentially dangerous and may be fatal.

Patients and Methods: Six children (4 boys and 2 girls) have swallowed multiple high strength and powerful rare earth element Neodymium magnets. Their ages ranged between (nine months to six-year-old). Four cases were subjected to open and two for laparoscopic exploration (one of them converted to open).

Results: multiple perforations of small intestine were found in four cases and multiple complicated enteroenteric fistulae in the other two cases. Simple closure of small bowel perforations were done in four cases and resection anastomosis were done in the other two cases. There was complication either intraoperative or postoperative.

Conclusion: Ingestion of Neodymium magnetic beads by children or co-ingestion of other metallic objects. are very hazardous. Early endoscopic removal is recommended if the patient presents immediately after ingestion. Surgical removal (laparoscopic or open) is mandatory in such cases. Awareness of parents through media is required to abandon the purchase of toys with high-strength magnetic beads or buckyballs.

Keywords: Enteroenteric Fstulae; Neodymium Magnetic Beads

Introduction

Foreign body (FB) ingestion is a common problem in infants and young children because they usually explore objects by putting them in the mouth. The peak incidence of occurrence ranges between 6 months and 3 years of age [1,2]. Ingestion of Neodymium magnetic beads by children or co-ingestion of other metallic objects are very hazardous.

The United States Consumer Product Safety Commission (CPSC) filed a lawsuit against the manufacturer of Bucky balls to force a recall in 2012 [3]. The North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) commended the CPSC for this action and supported a ban on the sale of high-powered neodymium magnets [8]. However, the annual case number of ingestions of high-powered neodymium magnets has still been increasing in the western world [4,5].

The aim of this research is to raise awareness and attention of health care givers and parents about the hazardous and danger of high-powered Neodymium Magnetic Beads ingestion by children either multiple magnets or single magnet with other metallic foreign body simultaneously or shortly after each other.

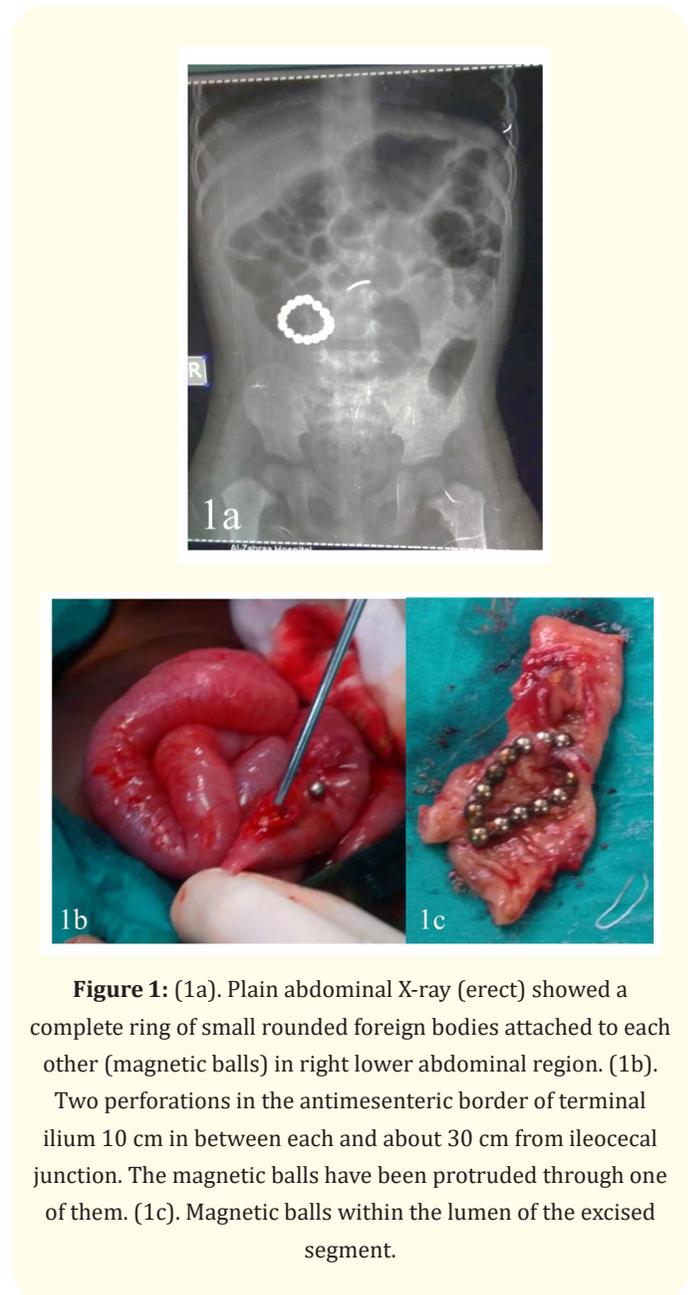
Case I

One year-old boy presented to our Emergency Department (ED) by his mother with history of abdominal pain for five days associated with vomiting, anorexia and constipation and she was suspecting that her baby swallowed foreign bodies. On examination, he was fully conscious, alert oriented, pale and dehydrated. Respiratory rate 34, heart rate 120b/m blood pressure 90\60. Chest showed good air entry bilaterally. Moderate abdominal distention with limited movement with respiration. There was generalized tenderness all over the abdomen with rigidity but no palpable masses. Pelvi-abdominal ultrasound revealed gaseous distension of bowel loops with rim of free fluid in between bowel loops and sluggish motility. Plain abdominal X-ray (erect) showed a complete ring of small rounded foreign bodies attached to each other (magnetic balls) in right lower abdominal region (Figure 1a). Lab work up showed, Hb 12.7 mg/dl, WBC, 15.900, Plat 148000, ALT 21, AST 30, Na 120, K 5.5, Urea 89, Creatinine 0.9 Ph 7.48, Hbco₂ So₂ 97, CRP 48.

After resuscitation and stabilization, exploratory laparotomy was done under general anesthesia revealed two perforations in the antimesenteric border of terminal ileum about 10 cm in between each other and 30 cm from ileocecal junction. The perforations were surrounded with minimal amount of pus and biogenic membrane around the free end of magnetic balls (Figure 1b, 1c). Peroperative abdominal plain X-ray was done by C-arm machine revealed no other foreign bodies. Resection and anastomosis was performed between healthy ends of ileum (30 cm from ileocecal valve). Post operative course was uneventful. The patient is discharged on the 6th postoperative day after tolerating oral feeding.

Case II

Five-year-old boy referred to our ED as a case of acute appendicitis from private hospital with history of abdominal pain associated with repeated bouts of non-bilious vomiting for last 20 hours. No past history of chronic medical illness or surgical disease. On examination, he was conscious, alert and pinkish on room air. His



vital signs were as follow; Temperature; 36,7°C, heart rate; 94 beat/min; blood pressure; 83/60 mmHg, respiratory rate; 22 cycle/min. No signs of external violence. Chest showed good air entry bilaterally.

Abdomen was rigid and tender all over the abdomen with rebound tenderness over the right iliac fossa. Lab work-up: Hg; 15.2, WBC; 21.03, other hematological and biochemical parameter were within normal limit. Abdominal ultrasound showed multiple dilated small bowel loops seen in abdominal and pelvic cavity with vigorous motion inside with moderate amount of fluid between. No localized collection. Enlarged mesenteric lymph nodes. Picture suggestive of acute intestinal obstruction. Abdominal X-ray (erect) showed a chain of small rounded foreign bodies attached to each other (magnet balls) in right lower abdominal region (Figure 2a).

Laparoscopic exploration showed huge distension of small bowel loops so converted to open laparotomy via lower midline incision. Exploration revealed dilation of proximal small bowel and distal small bowel obstruction. With foreign bodies transfixing three bowel loops. Two fistulae between three ileal loops (Figure 2b, 2c). Dissection of fistulous tracts were performed with extraction of chain of eight small magnet balls (3 mm) attached to each other. The openings of fistulae were trimmed and closed with Vicryl 4/0.

Appendectomy was done. Perioperative abdominal X-ray was done by C-arm machine revealed no other foreign bodies. Post operative course was uneventful. Oral feeding started on 4th post operative day and discharged on 5th day.

Case III

Four-year-old boy referred to our ED with history of abdominal pain associated with repeated bouts of bilious vomiting for 2 days. 14 days ago, the patient was admitted in peripheral hospital because of abdominal pain associated with non-bilious vomiting and diarrhea. Diagnosed as gastroenteritis and received medical treatment and discharged home without doing abdominal X-ray or ultrasound. No past history of chronic medical illness or surgical disease. On examination, he was conscious, alert and pinkish on room air. His vital signs were as follow; Temperature; 36.6°C, heart rate; 102 beat/min; blood pressure; 93/62 mmHg, respiratory rate; 22 cycle/min. No signs of external violence. Chest showed good air entry bilaterally. Abdomen was soft, lax, not distended, but there was palpable and tender mass in right iliac fossa. There was no organomegaly.

Lab work-up: Hg; 12.4, WBC; 13.94, other hematological and biochemical parameter were within normal limit. Abdominal X-ray

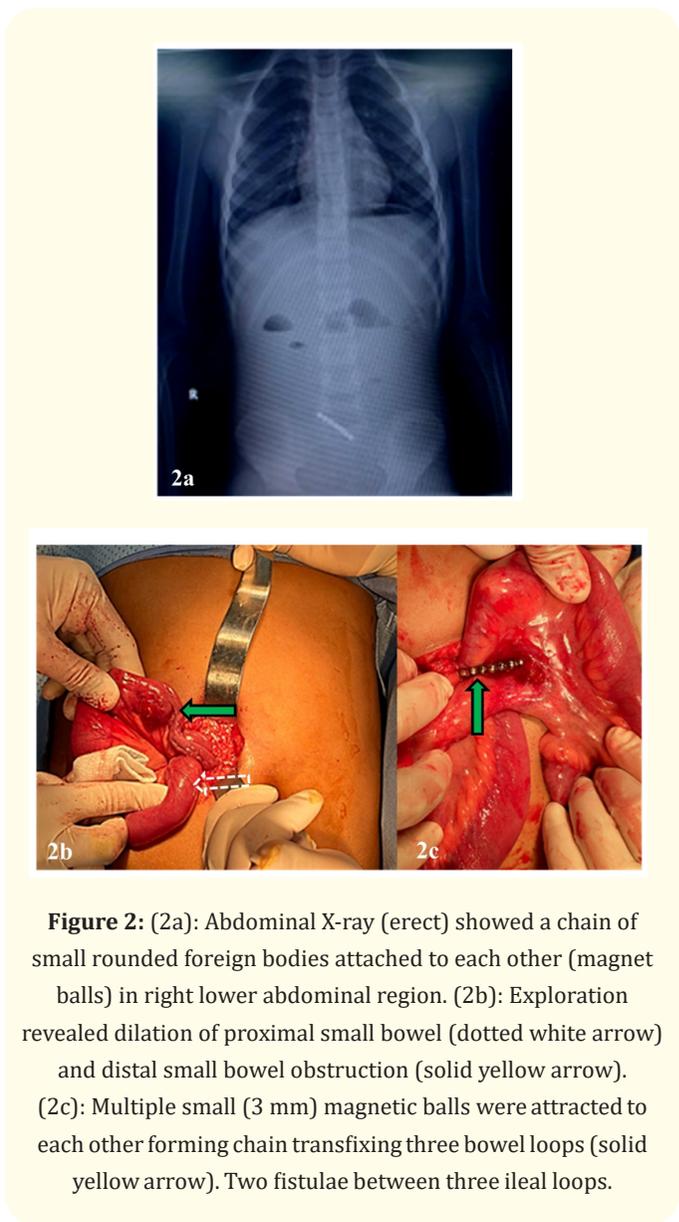


Figure 2: (2a): Abdominal X-ray (erect) showed a chain of small rounded foreign bodies attached to each other (magnet balls) in right lower abdominal region. (2b): Exploration revealed dilation of proximal small bowel (dotted white arrow) and distal small bowel obstruction (solid yellow arrow). (2c): Multiple small (3 mm) magnetic balls were attracted to each other forming chain transfixing three bowel loops (solid yellow arrow). Two fistulae between three ileal loops.

(erect) showed a complete ring of small balls attracted to each other in right lower abdominal region (Figure 3a). Abdominal ultrasound showed only minimal pelvic collection (Figure 3b).

Exploratory laparotomy revealed amalgamated mass of severely inflamed multiple loops of small bowels connecting to each other through multiple fistulae at different sites with entrapped loops of small intestine between fistulae in addition to multiple perforations sealed with omentum over protruding small magnet balls

(Figure 3c, 3d, 3e). Multiple small (3 mm) magnetic balls were attached to each other forming a ring across two adjacent small bowel loops (Figure 3f). Dissection of fistulous tracts between small bowel loops from each other and extraction of chain of magnet balls (18 magnet balls) (Figure 3g). Intraoperative abdominal plain X-ray was done by C-arm machine revealed no other foreign bodies. Resection and anastomosis was performed between healthy ends of ileum (20 cm from ileocecal valve). Post operative course was uneventful. Oral feeding started on 5th post operative day and discharged on 6th post operative day.

Case IV

Four-year-old boy referred to our ED with history of acute abdominal pain associated with repeated bouts of bilious vomiting

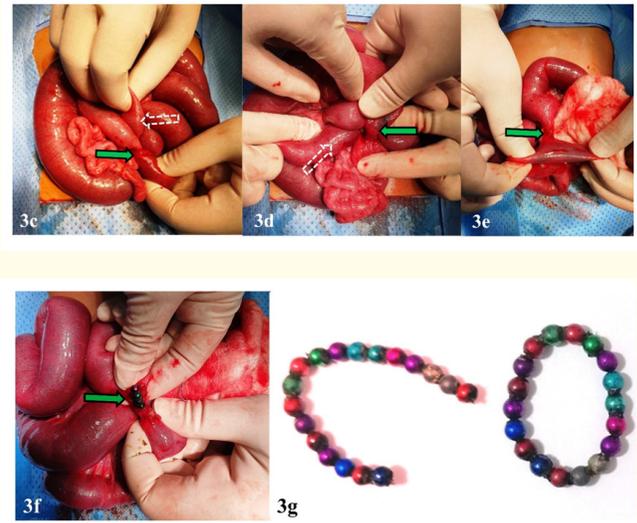


Figure 3: (3a): Abdominal X-ray (erect) showed a complete ring of small magnetic balls attracted to each other in right lower abdominal region. (3b): Abdominal ultrasound showed only minimal pelvic collection. (3c, 3d, 3e): Amalgamated mass of severely inflamed multiple loops of small bowels connecting to each other through multiple fistulous tracts at different sites (solid green arrow) with entrapped loops of small intestine between fistulae (dotted white arrow) in addition to multiple perforations sealed with omentum over protruding small magnetic balls. (3f) Multiple small (3mm) magnetic balls were attracted to each other forming a ring across two adjacent small bowel loops (solid green arrow) inside the fistulous tract. (3g) Magnetic balls after removal from bowel lumen.

for last 12 hours. No past history of chronic medical disease or surgical operations. On examination, he was conscious and alert. His vital signs were stable. There were no signs of external violence. Chest showed good air entry bilaterally. Abdomen was rigid and tender all over the abdomen with rebound tenderness over the right lower quadrant. Lab work-up: Hg; 16, WBC; 17., other parameters were within normal limits. Abdominal ultrasound revealed gaseous distension of bowel loops with moderate amount of fluid in between bowel loops with no localized collection and enlarged mesenteric lymph nodes. Plain abdominal X-ray (erect) showed a

chain of small rounded foreign bodies attached to each other (magnetic balls) in the right lower abdominal region (Figure 4).

Exploratory laparotomy showed perforation of terminal ileum through which the initial magnets of the chain were penetrating outside the bowel wall intraperitoneally. Extraction of chain of small magnet balls attached to each other. The site of perforation was trimmed and repaired using Vicryl 5/0. Peroperative abdominal X-ray was done by C-arm machine revealed no other foreign bodies. Post operative course was uneventful. Oral feeding started on 4th daypost operatively and discharged home on 7th post operative day.



Figure 4: Abdominal X-ray (erect) showed a chain of small rounded foreign bodies attached to each other (magnetic balls) in right lower abdominal region.

Case V

Nine-month-old girl admitted in pediatric ward with Gastroenteritis resolved and discharged home for 48 hours. Then re-admitted with the same picture but the mother mentioned the possibility of magnetic toy ingestion since the first time. The girl was vitally stable and a febrile her abdomen was distended and tender. Abdominal X-ray (erect) showed a complete ring of multiple small

magnetic balls attracted to each other in hypogastric region (Figure 5).

Under general endotracheal anesthesia and complete a septic technique, laparoscopic exploration was attempted, Unfortunately, the magnets were stuck to camera road and closed the vision. So, conversion to open laparotomy was decided. Exploratory laparotomy revealed Multiple small (3mm) magnetic balls were attached to each other forming a ring across two adjacent small bowel loops forming four perforations in terminal ileum. After extraction of the magnetic balls, all perforations were repaired by 5/0 interrupted sutures of PDS after trimming of their edges. Peroperative abdominal X-ray was done by C-arm machine revealed no other foreign bodies. Intraperitoneal drain was inserted and removed after 48 hours and started oral feeding at 5th day postoperative. Then discharged home on 7th day and followed up for 4 months in Outpatient department.

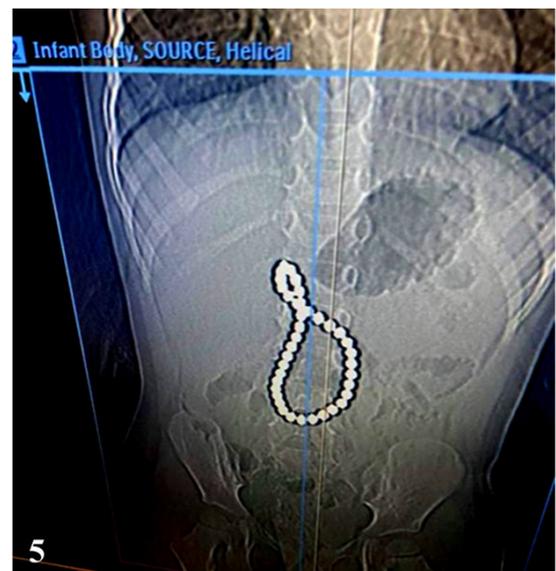


Figure 5: Abdominal X-ray (erect) showed a complete ring of multiple small magnet balls attracted to each other in hypogastric region.

Case VI

Two-year-old female girl, presented to ED with her parents. Her mother informed us about swallowing of multiple magnetic balls

10 hours ago and she brought two balls with her. No history of vomiting, abdominal pain or any other gastrointestinal symptoms. On examination: The girl was vitally stable, Temperature; 37°C, heart rate: 99 beat/min; blood pressure: 75/55 mmHg, Abdomen was soft, lax no distention or any palpable mass. Plain abdominal X-ray in supine position revealed a ring of multiple small magnet balls attached to each other in one end and chain in the other end in the left hypochondrium (Figure 6).

Under general endotracheal anesthesia and complete a septic technique, right transverse supraumbilical incision was performed. There was no peritoneal soiling, but the omentum was forming an edematous mass concealing the area of multiple small magnet balls. Meticulous dissection of the mass revealed single perforation in the jejunum, about 20 cm from the duodenojejunal junction (DJ) through which magnetic balls (26 balls) taking the shape of ring in one end and chain in the other end were protruding from the antimesenteric wall of the jejunum. They were extracted from the site of perforation. Trimming of the edge of the perforation was performed and sutured using Vicryl 4/0 in single layer. Perioperative abdominal X-ray was done by C-arm machine revealed no other foreign bodies. Post operative course was uneventful. Oral feeding started on 5th post operative day and discharged on 6th day postoperatively. There was no complaint during 6 months of follow-up in outpatient clinic.

Discussion

The incidence of high-powered neodymium magnets ingestion in children is increasing because of the availability of toys or entertainment products with high powered neodymium (or rare-earth) according to recent reports [6,7]. The magnetic force of high-powered neodymium magnets is 5 - to 20-fold stronger than that of traditional iron magnets [4,6,8]. Some high-powered magnet products, often sold in dozens to hundreds as Bucky balls or Bucky cubes, are small (0.3-0.6 cm, typically < 1 cm), round, and colorful which may increase the risk of ingesting multiple magnets [4,6,8].

Ingestion of multiple high-powered neodymium magnets or co-ingestion of other metallic objects with a magnet may lead to severe complications. These magnets pinched several loops of the bowel together, causing bowel obstruction, volvulus bowel ischemia, necrosis, intestinal perforation, peritonitis, complex enteroenteric fistulae, short-bowel syndrome caused by massive bowel resection, life-threatening injuries, and even death [6,9-19].



Figure 6: Plain abdominal X-ray in supine position showing ring of multiple small magnet balls attached to each other in the left hypochondrium.

All our cases were presented with GI symptoms and tenderness in their lower abdominal regions. Delay in diagnosis and consequently, the management can lead to a worse outcome. In our cases also there was a delay in presentation as the children were very young to express themselves and nobody witnessed the ingestion of magnets balls in five cases. In one case the mother suspected that her baby ingested FBs.

In 2020, Gayatri, *et al.* reported a case with a complex fistula through mesocolon between the stomach and two loops of jejunum after ingestion of high-powered multiple magnets [20].

In our study, there were multiple complicated enteroenteric fistulae in three cases and multiple perforations of the small intestine in three cases.

Plain abdominal x-ray forms the mainstay of the diagnosis and should be done in all cases of suspected FB ingestion and ill-defined vague abdominal pain in children [21].

One of our cases was admitted to peripheral hospital for treatment of gastroenteritis and discharged home.

After few days, brought by his mother to our ED with acute abdominal pain. A plain abdominal X-ray revealed the presence of a chain of multiple small magnets balls.

In a series by Richard Sola 47% of patients with magnet ingestion required intervention and 23% required abdominal surgeries [22].

All our cases required surgical intervention because they presented late with complications (intestinal perforations in four cases and intestinal fistulae in two cases).

Several algorithms have been published to help guide management [7,23-26].

In 2007, Richard Sola, *et al.* developed a management algorithm for the management of magnet ingestion in a big series of 89 patients from 2 hospitals [27]. They recommended admission of the patients in home a single or multiple magnets can't be differentiated by history and abdominal radiographs. Endoscopic removal is indicated for multiple magnets or a magnet and a second metallic foreign body in the stomach. For multiple magnets or a magnet and a second metallic foreign body past the stomach, laparoscopic removal is recommended if symptomatic or with obstructive signs on abdominal x-ray. Non-operative inpatient management consisting of bowel regimen and serial x-rays is recommended for asymptomatic children with multiple magnets or a magnet and a second metallic foreign body past the stomach. Endoscopic or laparoscopic removal may be considered if there is a failure of magnet progression after 48 hours [27].

To this algorithm we recommend screening of siblings of all patients ingested high powered magnets by abdominal radiograph.

In 2020 Holtz, *et al.* advised screening of foreign bodies with a plain X-ray of the abdomen and chest in disabled children with a history of recent abdominal pain prior to MRI because they found severe artifacts on brain MRI as result of multiple magnet ingestion which are detected later on by abdominal plain x-ray [27,28].

In all our cases, Peroperative abdominal plain X-ray was taken in the operative room by a C-arm machine before closure of the

abdominal wall to be sure that there were no other missed magnet balls or other foreign bodies. The postoperative course was uneventful in all cases. They were discharged on 5th to 7th postoperative day. They were doing well during one year follow up in outpatient clinic. The siblings of all our cases were also screened by abdominal X-ray which were negative.

Conclusion

All primary health caregivers should be aware of the danger and complications of ingestion of multiple high-powered neodymium magnetic balls by children or co-ingestion of other metallic objects with a magnet. Early endoscopic retrieval is mandatory if the patient presents immediately after ingestion. Laparoscopic or open surgical extraction is recommended in such cases. Awareness of parents through newspapers, radio, television and social media is required to abandon the purchase of toys with high-strength magnetic beads or buckyballs.

Bibliography

1. Webb WA. "Management of foreign bodies of the upper gastrointestinal tract". *Gastroenterology* 94 (1988): 204-216.
2. Al-Saied G., *et al.* "Unusual cause of small-bowel obstructions in infants: A warning letter to the parents". *Journal of Pediatric Surgery Case Reports* 11 (2016): 39-43.
3. Reeves PT, *et al.* "Trends of magnet ingestion in children, an ironic attraction". *Journal of Pediatric Gastroenterology and Nutrition* 66 (2018): e116-121.
4. Strickland M., *et al.* "Magnetic foreign body injuries: a large pediatric hospital experience". *Journal of Pediatric* 165 (2014): 332-335.
5. Dahshan A. "Management of ingested foreign bodies in children". *Journal of the Oklahoma State Medical Association* 94 (2001): 18306.
6. Brown JC., *et al.* "Too attractive: the growing problem of magnet ingestions in children". *Pediatric Emergency Care* 29 (2013): 1170-1174.
7. Abbas MI, *et al.* "Magnet ingestions in children presenting to US emergency departments, 2002-2011". *Journal of Pediatric Gastroenterology and Nutrition* 57 (2013): 18-22.

8. Hodges NL, et al. "Rare-earth magnet ingestion related injuries in the pediatric population: a review". *American Journal of Lifestyle Medicine* 11 (2015): 259-263.
9. Shalaby MS. "How dangerous a toy can be? The magnetic effect". *Archives of Disease in Childhood* 100 (2015): 1049-1050.
10. Mandhan P, et al. "Troubling toys: rare earth magnet ingestion in children causing bowel perforations". *Case Reports in Pediatrics* 2014 (2014): 908730.
11. Strickland M, et al. "Magnetic foreign body injuries: a large pediatric hospital experience". *Journal of Pediatrics* 165 (2014): 332-335.
12. Waters AM, et al. "Surgical management and morbidity of pediatric magnet ingestions". *Journal of Surgery Research* 199 (2015): 137-140.
13. Hussain SZ, et al. "Management of ingested magnets in children". *Journal of Pediatric Gastroenterology and Nutrition* 55 (2012): 239-242.
14. Cozzarelli R, et al. "Abdominal pain secondary to ileocecal fistulae by ingestion of multiple magnetic bodies: clinical Case". *Revista Chilena de Pediatría* 88 (2017): 428e30.
15. Si X, et al. "Multiple magnetic foreign bodies causing severe digestive tract injuries in a child". *Case Report Gastroenterology* 10 (2016): 720-727.
16. Olczak M and Skrzypek E. "A case of child death caused by intestinal volvulus following magnetic toy ingestion". *Legal Medicine (Tokyo)* 17 (2015): 184-187.
17. De Roo AC, et al. "Rare-earth magnet ingestion related injuries among children, 2000d2012". *Clinical Pediatrics (Phila)* 52 (2013): 1006-1013.
18. Blevrakis E, et al. "Multiple magnet ingestion causing intestinal obstruction and entero-enteric fistula: which imaging modality besides radiographs? A case report". *Annals of Medicine and Surgery (Lond)* 31 (2018): 29-33.
19. Butterworth J and Feltis B. "Toy magnet ingestion in children: revising the algorithm". *Journal of Pediatric Surgery* 42 (2007): 3-5.
20. Wildhaber BE, et al. "Ingestion of magnets: innocent in solitude, harmful in groups". *Journal of Pediatric Surgery* 40 (2005): 33-35.
21. Gayatri S Munghatec, et al. "Multiple magnetic foreign bodies causing complex intestinal fistula". *Journal of Pediatric Surgery Case Reports* 63 (2020) 101661.
22. Cherchi V, et al. "Ileocecal fistula caused by multiple foreign magnetic bodies ingestion". *Case Reports in Surgery* 2018 (2018): 7291539.
23. Sola Jr R, et al. "Magnet foreign body ingestion: rare occurrence but big consequences". *Journal of Pediatric Surgery* 53.9 (2018): 1815-1819.
24. Vijaysadan V, et al. "Revisiting swallowed troubles: intestinal complications caused by two magnets-a case report, review and proposed revision to the algorithm for the management of foreign body ingestion". *Journal of the American Board of Family Medicine* 19.5 (2006): 511-516.
25. Hussain SZ, et al. "Management of ingested magnets in children". *Journal of Pediatric Gastroenterology and Nutrition* 55.3 (2012): 239-242.
26. Butterworth J and Feltis B. "Toy magnet ingestion in children: revising the algorithm". *Journal of Pediatric Surgery* 42.12 (2007): 3.
27. Wong HH and Phillips BA. "Opposites attract: a case of magnet ingestion". *CJEM* 11.5 (2009): 493-495.
28. Holtz T K, et al. "Unexpected finding of ingested magnetic toys in a child undergoing cerebral MRI". *Journal of Pediatric Surgery Case Reports* 61 (2020): 101579.
29. Richard Sola Jr, et al. "Magnet foreign body ingestion: rare occurrence but big consequences". *Journal of Pediatric Surgery* 53 (2017): 1815-1819.