

Chronic jejuno-colonic fistula and intestinal malabsorption due to multiple magnet ingestions: A case report and systematic review

 **Rahşan Özcan,¹**  **Ali Ekber Hakalmaz,¹**  **Ayşe Kalyoncu Uçar,²**  **Ömer Beser,³**  **Şenol Emre¹**

¹Department of Pediatric Surgery, İstanbul University-Cerrahpasa, Cerrahpasa Faculty of Medicine, İstanbul-Türkiye

²Department of Radiology, İstanbul University-Cerrahpasa, Cerrahpasa Faculty of Medicine, İstanbul-Türkiye

³Department of Pediatric Gastroenterology, İstanbul University-Cerrahpasa, Cerrahpasa Faculty of Medicine, Hepatology and Nutrition, İstanbul-Türkiye

ABSTRACT

Magnet ingestion in children can lead to serious complications, both acutely and chronically. This case report discusses the treatment approach for a case involving multiple magnet ingestions, which resulted in a jejuno-colonic fistula, segmental intestinal volvulus, hepatosteatosis, and renal calculus detected at a late stage. Additionally, we conducted a literature review to explore the characteristics of intestinal fistulas caused by magnet ingestion. A six-year-old girl was admitted to the Pediatric Gastroenterology Department presenting with intermittent abdominal pain, vomiting, and diarrhea persisting for two years. Initial differential diagnoses included celiac disease, cystic fibrosis, inflammatory bowel disease, and tuberculosis, yet the etiology remained elusive. The Pediatric Surgery team was consulted after a jejuno-colonic fistula was suspected based on magnetic resonance imaging findings. The physical examination revealed no signs of acute abdomen but showed mild abdominal distension. Subsequent upper gastrointestinal series and contrast enema graphy confirmed a jejuno-colonic fistula and segmental volvulus. The family later reported that the child had swallowed a magnet two years prior; and medical follow-up had stopped after the spontaneous expulsion of the magnets within one to two weeks. Surgical intervention was necessary to correct the volvulus and repair the large jejuno-colonic fistula. To identify relevant studies, we conducted a detailed literature search on magnet ingestion and gastrointestinal fistulas according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. We identified 44 articles encompassing 55 cases where symptoms did not manifest in the acute phase and acute abdomen was not observed. In 29 cases, the time of magnet ingestion was unknown. Among the 26 cases with a known ingestion time, the average duration until fistula detection was 22.8 days (range: 1-90 days). Fistula repairs were performed via laparotomy in 47 cases.

Keywords: Intestinal volvulus; jejuno-colonic fistula; magnet ingestion.

INTRODUCTION

Magnet ingestion in children, though rare, poses serious health risks. Recently, there has been a noticeable increase in such incidents, attributed to the widespread use of high-powered magnets in toys.^[1] The medical literature has recorded vari-

ous complications from magnet ingestions in children, such as gastrointestinal mucosa erosion, intestinal perforation, peritonitis, volvulus, and the formation of fistulas.^[2-4]

The onset and timing of symptoms after magnet ingestion can vary widely. While some children may remain asymptomatic, others may develop acute abdominal symptoms shortly after

Cite this article as: Özcan R, Hakalmaz AE, Uçar AK, Beser O, Emre S. Chronic jejuno-colonic fistula and intestinal malabsorption due to multiple magnet ingestions: A case report and systematic review. *Ulus Travma Acil Cerrahi Derg* 2024;30:361-369.

Address for correspondence: Rahşan Özcan

Department of Pediatric Surgery, İstanbul University-Cerrahpasa, Cerrahpasa Faculty of Medicine, İstanbul, Türkiye

E-mail: rozcan1@gmail.com

Ulus Travma Acil Cerrahi Derg 2024;30(5):361-369 DOI: 10.14744/tjtes.2024.50845

Submitted: 16.04.2024 Revised: 02.05.2024 Accepted: 03.05.2024 Published: 13.05.2024

OPEN ACCESS This is an open access article under the CC BY-NC license (<http://creativecommons.org/licenses/by-nc/4.0/>).



ingestion.^[5-8] Intestinal fistulas may form during both acute and chronic phases, especially when multiple magnets are ingested. Research shows that mucosal damage from ingesting multiple magnets can occur within eight hours; however, detailed timelines for fistula formation are underdocumented.^[9] The diagnosis of such conditions can be challenging, particularly when the timing of ingestion is unclear and when complications like fistula develop without initial signs of perforation or peritonitis.

In this paper, we present a case involving a jejuno-colonic fistula and volvulus, identified during an investigation for intestinal malabsorption and chronic diarrhea. This case is unique in the literature as it deviated from typical presentations: there were no acute symptoms post-ingestion, the magnets were expelled naturally from the gastrointestinal tract, and the family did not initially disclose the history of magnet ingestion.

CASE REPORT

A six-year-old girl was evaluated by Pediatric Gastroenterology for persistent intermittent abdominal pain, vomiting, steatorrhea, and diarrhea, which had been ongoing for two years. Initial assessments considered diagnoses such as Celiac disease, inflammatory bowel disease (IBD), cystic fibrosis, tuberculosis, and metabolic disorder. An abdominal X-ray showed dilated intestinal loops, while abdominal ultrasonography revealed severe hepatosteatosis and a stone in the right mid-ureter. Colonoscopy performed by gastroenterology identified mild hyperemia in the rectum, but no other abnormalities or fistulas were observed. A biopsy of the rectum led to the initiation of treatment for IBD due to findings of active colitis. However, her symptoms persisted without improvement, prompting a referral to the Pediatric Surgery Department due to suspicions of an intestinal fistula and volvulus, as indicated by magnetic resonance imaging (MRI) conducted for IBD.

During the physical examination by the pediatric surgeon,

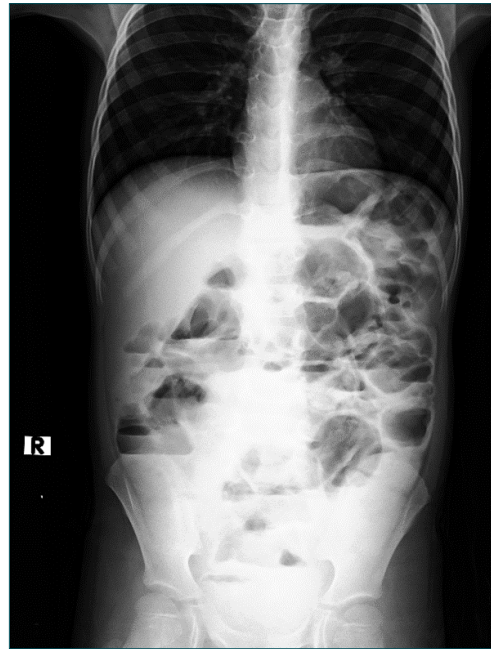


Figure 1. Upright abdominal X-ray showing distended jejunal and ileal loops filled with gas, and no visible foreign body present.

mild abdominal distension was noted, though there were no signs of acute abdomen. The family eventually disclosed that the patient had ingested multiple magnets two years prior, which had been monitored at another center. The follow-up concluded when the swallowed magnets were expelled in the stool within 1-2 weeks. The symptoms started 2-3 months following this incident, but initially, the family did not connect the symptoms with the magnet ingestion nor felt the need to disclose this earlier.

Further diagnostic imaging included an abdominal X-ray, which showed distended jejunal and ileal loops filled with gas, though no foreign bodies were visible (Fig. 1). Given the

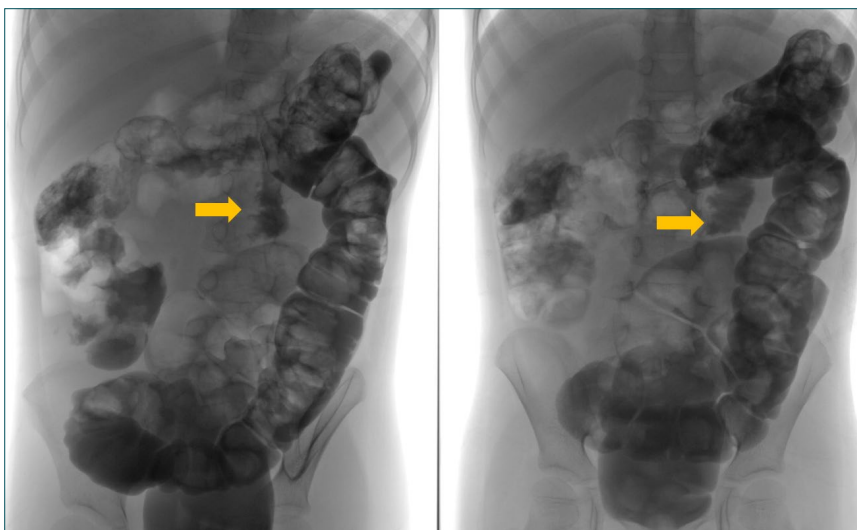


Figure 2. Contrast enema radiography depicting a jejunocolonic fistula.

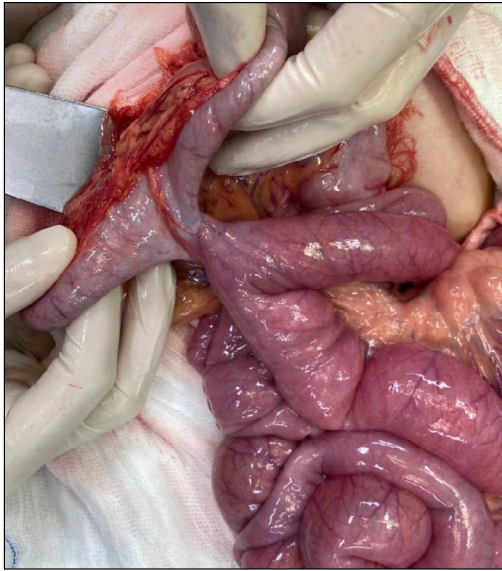


Figure 3. Jejunocolonic fistula resulting from magnet ingestion.

ongoing suspicion of a fistula, an upper gastrointestinal (GI) series and a contrast enema were performed, revealing a fistula between the jejunum and the transverse colon (Fig. 2). Follow-up urinary ultrasonography identified a 6 mm stone in the right mid-ureter with proximal dilatation, but no stones were present in the pelvis or renal calyces. Advanced urinary examination (such as Dimercaptosuccinic Acid (DMSA) scanning) was not performed due to the satisfactory renal parenchymal echogenicity and parenchymal thickness observed on ultrasonography (USG), coupled with the initial diagnosis of volvulus.

Considering the jejunocolonic fistula that resulted from magnet ingestion might be associated with chronic malabsorption, hepatosteatosis, and steatorrhea, and given the suspicion of segmental volvulus, surgical exploration was deemed necessary. During the laparotomy, performed through a midline supraumbilical incision, a fistula was discovered between the jejunal loop, 25 cm distal to the ligament of Treitz, and the transverse colon (Fig. 3). Two instances of segmental volvulus in the mesentery secondary to the fistula were identified, but no necrosis was observed (Fig. 4). The torsion was corrected, and the colonic and jejunal loops were clamped on both sides of the fistula using bowel clamps. The fistula was then incised with scissors, separating the jejunum and colon. Vertical incisions in the colon and jejunum were repaired horizontally using the Heineke-Mikulicz technique, with the first layer of continuous sutures and the second layer consisting of Lambert sutures. The right colon was retracted medially to access the retroperitoneum, where a stone in the right mid-ureter was palpated. The stone was removed via ureterotomy, and a JJ catheter was inserted into the ureter. A Jackson-Pratt drain was positioned in the right paracolic area, and the abdomen was closed.

No additional underlying pathology was found in the jejunum and colon biopsies. The patient, whose stone analysis showed



Figure 4. Segmental volvulus caused by jejunocolonic fistula.

calcium oxalate, was discharged with medical management on the eighth postoperative day. Follow-up indicated a regression of gastrointestinal symptoms. The case is currently under joint care by the gastroenterology and nephrology departments.

Verbal consent was obtained from the patient's parents for inclusion in this report.

Search and Selection Strategy

A comprehensive search was conducted to identify all available studies on magnet ingestion and gastrointestinal fistula, adhering to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.^[10] We performed systematic searches in February 2024 through the PubMed and Web of Science databases, using the search terms: "magnet ingestion" AND "fistula." Titles and abstracts were screened to exclude non-relevant studies, and full texts were evaluated with data systematically analyzed. The inclusion criteria included: (1) children aged 0-18; (2) case reports and case series published in English; and (3) cases involving only gastrointestinal fistulas, without an acute abdomen. Exclusion criteria were: (1) review articles; (2) non-English language publications; (3) cases presenting with peritonitis or perforation due to magnet ingestion; and (3) studies involving adult patients (Fig. 5).

RESULTS

Gastrointestinal fistulas attributable to magnet ingestion were reported in 55 pediatric cases (M: 38, F: 17) across 44 studies in the literature (Table 1).^[11-56] The median age of these cases was 4.6 years, with a range from 9 months to 16 years.

The most frequently reported symptom was abdominal pain (n=34). Duration of symptoms was documented in 48 cases, averaging 8.75 days, with a range from 0 to 180 days.

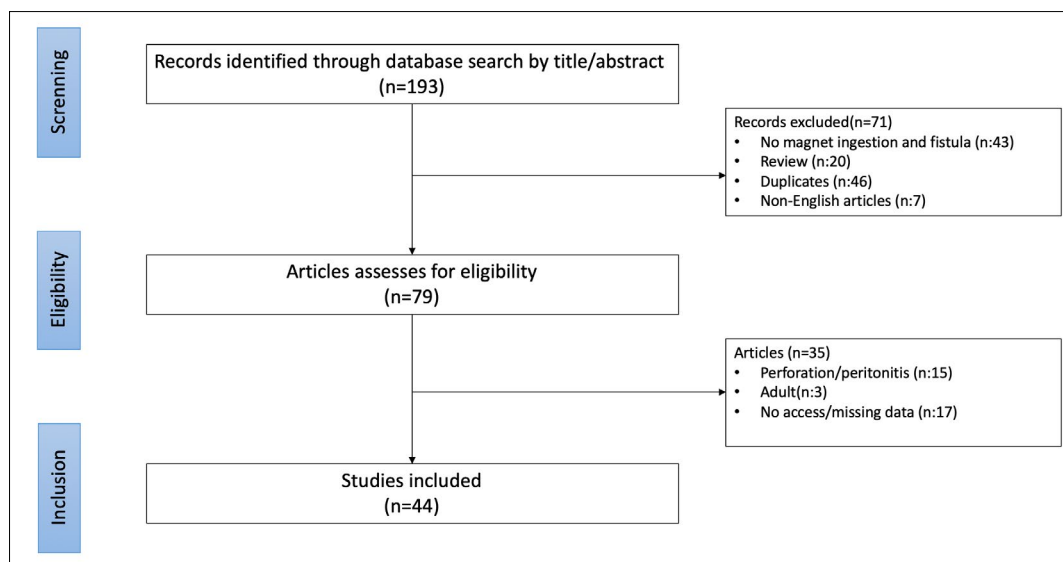


Figure 5. Flowchart illustrating the review process and article inclusion criteria.

In 29 cases, the exact timing of magnet ingestion was unknown. Among 26 cases with a known ingestion timeline, the average time until discovery was 22.8 days (range: 1-90 days). The average number of ingested magnets was 8.7 (range: 1-32), and the average number of fistulas was 1.4 (range: 1-7).

Enteric fistulas were the most common, followed by gastric fistulas (Table 2).

Out of the 8 cases that underwent endoscopic treatment, 7 were placed under conservative monitoring after fistula detection following magnet removal. In one of these cases, a gastroduodenal fistula was closed using clips. Additionally, fistula repair was performed by laparotomy in 47 cases.

No complications were noted in cases managed conservatively. However, one case of abdominal wall dehiscence was reported following a laparotomy for fistula repair, while the remaining 46 cases had uneventful recoveries.

DISCUSSION

High-powered magnet ingestion is an increasingly prevalent issue that poses significant health concerns for the pediatric population. It has been observed that in 80% of cases, magnets spontaneously exit the gastrointestinal tract, whereas endoscopic intervention may be necessary in approximately 10-20% of cases. Complications such as obstruction, perforation, or fistula, which require surgical intervention, occur in about 1% of cases.^[57]

High-powered magnets, commonly found in toys, can bring adjacent intestinal segments into close proximity, leading to pressure necrosis and subsequent fistula formation. It has been reported that mucosal damage in the intestine can begin as early as eight hours post-ingestion.^[9] However, the timing of fistula formation is unclear. In the literature, the timing of magnet ingestion was documented in only 26 out of 55 cases,

with an average duration of 22.8 days (range: 1-90 days). Fistulas were detected even in cases with a history as short as one day.^[31] No specific localization for fistulas caused by magnets is specified in the literature. However, when multiple magnets pass through the pylorus, they can become separated due to intestinal motility, drawing different intestinal segments together.^[58] In our study, 58% of the fistulas detected among the 55 cases examined were enteric fistulas. Similarly, in our case, a fistula formed between the jejunum and the colon.

The number of ingested magnets, the presence of other metallic objects alongside the magnet, and the magnetic force are critical factors influencing fistula formation. Particularly when two or more magnets are swallowed, the risks of perforation, peritonitis, and intestinal fistula notably increase.^[59,60] The average number of magnets identified in our study was 8.7 (range: 1-32). In only one documented case of magnet ingestion, an accompanying metallic foreign object and a magnet pulled two separate intestinal segments into contact, resulting in a fistula. Another crucial factor in fistula development is the attractive force of the ingested magnet. Magnets containing iron, boron, and neodymium are known to be 5 to 10 times stronger than plain iron magnets.^[61] This increased strength facilitates fistula formation by exerting significant pressure between two segments of the gastrointestinal tract. In our case study, the family reported that the swallowed magnets contained neodymium.

It has been documented that abdominal symptoms typically manifest within 1-7 days following magnet ingestion.^[18] However, clear information regarding the timing of fistula formation and the onset of fistula-related symptoms remains elusive. In the literature review, the most common complaints associated with magnet ingestion and resultant intestinal fistulae included nonspecific abdominal pain and vomiting. There were no signs of acute abdomen in any of the cases. Two

Table I. Comparison of results between three different suture material

Study (Year)	Age/ Sex	Symptoms	Duration of Symptoms	Time to Magnet	Number of Magnets	Fistula Location	Number of Fistulas	Management	Outcome
Ali et al. ⁽¹¹⁾	9 yrs/F	1, 2	3 days	Unknown	20	Gastrocolonic	1	LP	Uneventful
Surd et al. ⁽¹²⁾	17 mo/M	2, 3	2 days	Unknown	28	Gastroenteric	2	LP	Uneventful
Afzal et al. ⁽¹³⁾	20 mo/M	5	0 days	60 days	21	Enteroenteric	3	LS, LP	Uneventful
	42 mo/M	1	2 days	Unknown	21	Duodenocolonic	1	LS, LP	Uneventful
	4 yrs/M	5	0 days	14 days	12	Enteroenteric	1	LS, LP	Uneventful
Lawrence et al. ⁽¹⁴⁾	32 mo/M	2	1 day	14 days	19	Gastrojejunal	Multiple	E, LP	Uneventful
Munghate et al. ⁽¹⁵⁾	1 yr/M	1	8 days	30 days	Multiple	Gastrojejunal Jejunojunal	2	LP	Uneventful
Feng JiMervin et al. ⁽¹⁶⁾	52 mo/F	2	1 day	7 days	Multiple	Jejunoileal	2	LP	Uneventful
Alkhamisy et al. ⁽¹⁷⁾	4 yrs/M	1, 2	3 days	Unknown	13	Gastrojejunal	1	LP	Uneventful
Kim et al. ⁽¹⁸⁾	9 mo/F	4	1 day	Unknown	5	Jejunoileal	1	LP	Uneventful
Al-Saied et al. ⁽¹⁹⁾	4 yrs/M	1, 2	2 days	Unknown	18	Enteroenteric	Multiple	LP	Uneventful
Nyugen et al. ⁽²⁰⁾	4 yrs/M	0	-	Unknown	Multiple	Jejunojunal	2	E, LS, LP	Uneventful
Zhang et al. ⁽²¹⁾	1 yr/M	2	1 day	9 days	3	Gastrojejunal	1	E, LP	Uneventful
Romine et al. ⁽²²⁾	10 yrs/M	1, 2	4 days	Unknown	Multiple	Jejunocecal	2	LP	Uneventful
	5 yrs/M	1, 2	1 day	30 days	2	Ileocecal	2	LP	Uneventful
	2 yrs/F	1, 2	4 days	Unknown	3	Jejunoileal	1	LP	Uneventful
	7 yrs/F	1, 2	7 days	7 days	5	Ileocolonic	2	LP	Uneventful
Chavan et al. ⁽²³⁾	4 yrs/F	1	10 days	30 days	2	Gastroduodenal	1	E, clip	Uneventful
	7 yrs/M	1	14 days	90 days	2	Duodenojejunal	1	E, conservative	Uneventful
	5 yrs/M	1	1 day	2 days	2	Duodenojejunal	2	E, conservative	Uneventful
Lorenze et al. ⁽²⁴⁾	15 mo/F	0	0 days	Unknown	11	Gastropyloric	1	E, conservative	Uneventful
Dias et al. ⁽²⁵⁾	12 yrs/M	1	15 days	Unknown	1	Jejunocolonic	1	E, LP	Uneventful
Taher et al. ⁽²⁶⁾	4 yrs/M	5	0 days	30 days	5	Enteroenteric	7	LP	Uneventful
Zachos et al. ⁽²⁷⁾	4 yrs/M	1	2 days	30 days	14	Jejunoileal	2	LP	Uneventful
Phen et al. ⁽²⁸⁾	19 mo/M	2	90 days	Unknown	13	Gastroduodenal	1	E, conservative	Uneventful
Blevrakis et al. ⁽²⁹⁾	9 yrs/M	1, 2	3 days	10 days	2	Ileoileal	1	LP	Uneventful
Cherchi et al. ⁽³⁰⁾	11 yrs/M	1	3 days	60 days	2	Ileocecal	1	LP	Uneventful
Merchant et al. ⁽³¹⁾	22 mo/M	5	0 days	1 day	8	Gastrogastric	1	E, conservative	Uneventful
Pogorelic et al. ⁽³²⁾	2 yrs/F	1	1 day	10 days	25	Ileoileal	1	LP	Uneventful
Kisku et al. ⁽³³⁾	2 yrs/M	5	0 days	10 days	2	Duodenojejunal	1	LP	Uneventful
Pederiva et al. ⁽³⁴⁾	4 yrs/M	2	1 day	Unknown	2	Ileoileal	1	LP	Uneventful
Macedo et al. ⁽³⁵⁾	18 mo/F	5	0 days	7 days	2	Ileoileal	1	LP	Uneventful
Kosut et al. ⁽³⁶⁾	4 yrs/M	1, 2	5 days	Unknown	3	Ileocolonic	1	E, LS	Uneventful
	2 yrs/M	1, 2	7 days	Unknown	19	Gastroenteric	2	E, LS	Uneventful
	4 yrs/M	1, 2	7 days	Unknown	3	Enterocolonic	1	E, LS	Uneventful
Tsai et al. ⁽³⁷⁾	15 mo/M	1, 2	6 days	Unknown	6	Enteroenteric	1	E, LS, LP	Uneventful
Wooten et al. ⁽³⁸⁾	16 yrs/M	1, 2	1 day	2 days	3	Gastrocecal	1	LS, LP	Uneventful
Clarke et al. ⁽³⁹⁾	8 yrs/M	1	2 days	Unknown	Multiple	Enteroenteric	Multiple	LP	Uneventful
Ahmed et al. ⁽⁴⁰⁾	5 yrs/F	1	1 day	60 days	2	Jejunocecal	1	LP	Uneventful
Saaed et al. ⁽⁴²⁾	11 yrs/M	1	Unknown	30 days	1	Jejunocolonic	1	LP	Uneventful
Kabre et al. ⁽⁴³⁾	8 yrs/M	1, 2	1 day	Unknown	2	Enteroenteric	1	LP	Uneventful
Palanivelu et al. ⁽⁴⁴⁾	2 yrs/M	5	Unknown	Unknown	4	Gastrojejunal	1	E, LS	Uneventful

Vijaysadan et al. ⁽⁴⁵⁾	11 yrs/M	1, 2	Unknown	30 days	2	Jejunioileal	1	LP	Uneventful
Uchida et al. ⁽⁴⁶⁾	2 yrs/F	2	5 days	Unknown	32	Duodenojejunal Jejuniojejunal	2	LP	Abdominal wall dehiscence
Liu et al. ⁽⁴⁷⁾	7 yrs/M	1	3 days	Unknown	10	Duodenocolonic	1	LS, LP	Uneventful
Ohno et al. ⁽⁴⁹⁾	7 yrs/M	1, 2	Unknown	Unknown	15	Gastroduodenal	1	E, conservative	Uneventful
Chung et al. ⁽⁵⁰⁾	15 mo/M	1	180 days	Unknown	7	Ileoileal	3	LP	Uneventful
Lee et al. ⁽⁵¹⁾	2 yrs/F	1, 2	Unknown	Unknown	2	Jejunioileal	1	LP	Uneventful
	1.5 yrs/F	5	11 days	11 days	4	Gastrojejunal	1	E, LP	Uneventful
Kubota et al. ⁽⁵²⁾	15 mo/F	2	Unknown	Unknown	7	Jejunioileal	1	LP	Uneventful
Honzumi et al. ⁽⁵³⁾	1.5 yrs/F	1, 2	Unknown	Unknown	11	Jejunioileal	1	LP	Uneventful
Hwang et al. ⁽⁵⁴⁾	12 yrs/M	2	4 days	Unknown	22	Gastroduodenal	2	E, conservative	Uneventful
Quezada et al. ⁽⁵⁵⁾	15 mo/F	1, 3	3 days	Unknown	20	Esophagogastric	1	E, LS, LP	Uneventful
Kumar et al. ⁽⁵⁶⁾	2 yrs/F	1, 2	3 days	Unknown	1	Ileocecal	1	LP	Uneventful

Symptoms: 0 - Incidental, 1 - Abdominal pain, 2 - Vomiting, 3 - Gastrointestinal (GI) bleeding, 4 - Foreign body (FB) in stool, 5 - Only complaint is swallowing of FB. E: Endoscopy; LP: Laparotomy; LS: Laparoscopy.

Table 2. Fistula localization

Fistula Localization	Number (n)
Gastric Fistulas	18
Esophagogastric	1
Gastrogastic	1
Gastropyloric	1
Gastroduodenal	5
Gastroenteric	10
Duodenal Fistulas	6
Duodenojejunal	4
Duodenocolonic	2
Enteric Fistulas	33
Jejuniojejunal	3
Jejunioileal	8
Jejunocolonic	4
Ileoileal	5
Ileocolonic	5
Enteroenteric (unknown)	8

cases involving esophagogastric and gastroenteric fistulas presented with upper GI bleeding due to mucosal erosion within the fistula tract.^[12,55] Additionally, the coexistence of a fistula and volvulus has been reported in the literature.^[38] Initially, the only symptom observed in our case was nonspecific abdominal pain. However, diarrhea and malabsorption became prominent complaints three months after magnet ingestion. Unlike typical cases reported in the literature, the magnets in our study exited the gastrointestinal system early. Nonetheless, the resultant fistula allowed jejunal contents to pass directly into the colon, leading to impaired intestinal absorption and malabsorption, hepatosteatorrhea, and segmental volvulus.

Therefore, it is imperative to consider that various gastrointestinal pathologies may arise from magnet ingestion during both acute and chronic periods. The presence of nonspecific symptoms may complicate the diagnostic process, especially in cases where magnet ingestion was not directly observed.

The adequacy of radiological examinations in diagnosing fistulas is subject to debate. For cases with a history of magnet ingestion, the initial radiological assessment typically includes an anterior and lateral standing direct abdominal radiograph.^[62] A fistula should be suspected if multiple magnets persist on serial radiographs or are detected in atypical locations.^[14] Depending on the suspected location of the fistula, employing oral or rectal contrast can help ascertain its presence and extent. Oral contrast-enhanced computed tomography (CT) or MRI scans may also offer diagnostic insights. However, if a magnet is detected in the abdomen, the use of MRI should be avoided due to the risk of complications related to the magnet.^[62] Endoscopy is also instrumental in identifying fistulas. In our literature review, a fistula diagnosis was confirmed during endoscopy or laparotomy in all 55 cases. Where endoscopy was performed, the presence of a magnet within the fistula simplified the identification of its location. However, fistulas without foreign bodies may be overlooked if not meticulously examined. In our particular case, as there was initially no foreign body, and the history of foreign body ingestion was unknown, various other diagnoses were initially considered. The diagnosis of a jejunocolonic fistula, missed during a colonoscopy performed by gastroenterology, was eventually confirmed through radiological examination.

Currently, there is no consensus on the treatment of intestinal fistulas resulting from magnet ingestion. Treatment options range from conservative management and endoscopic fistula closure to surgical intervention. Some studies advocate for the endoscopic removal of the foreign body and subse-

quent monitoring if the fistula, caused solely by magnets, is not associated with peritonitis or perforation. However, details about the follow-up period and long-term outcomes are not available. In the literature review, conservative follow-up was performed in 42% of the 17 cases where a stomach-related fistula was detected after the magnet had been removed from the fistula tract using an endoscope.^[23-24,28,31,49,54] Endoscopic intervention procedures are also feasible. For instance, Chavan et al. reported that in one case, a gastroduodenal fistula was closed endoscopically using clips.^[23] It was noted that all fistulas related to the small intestine and colon were surgically repaired. Even when magnets are expelled spontaneously, as observed in our case, the potential long-term consequences of unnoticed and untreated intestinal fistulas should not be underestimated. In our case, the jejunocolonic fistula mimicked blind lobe syndrome, leading to hepatosteatosis, chronic diarrhea, and volvulus. Due to these complications, we recommend surgical repair, particularly for fistulas involving the small intestine and colon.

The treatment outcomes and prognosis were generally favorable in the 55 cases reviewed from the literature, where fistulas developed without acute abdominal symptoms or perforation. In this series, only one case experienced abdominal wall dehiscence following fistula repair via laparotomy, while the remaining 46 cases had uneventful follow-ups. Our case similarly had an uneventful two-year follow-up after surgical repair of the fistula and correction of the volvulus. However, it is crucial to remember that necessary precautions must be taken before magnet extraction and before fistula formation occurs.^[62] The first step involves taking preventative measures against magnet ingestion, an increasingly reported and significant health hazard. It is vital to restrict children's access to these magnets, ensure young children are supervised during play, and enact legal regulations concerning the use of magnets in toys.^[61] The risk of developing complications is particularly high in children who ingest multiple magnets. Such cases require close monitoring, and the magnets should be removed from the gastrointestinal tract using endoscopic or surgical methods promptly.

CONCLUSION

In conclusion, the most critical step in safeguarding against potential complications from magnet ingestion involves implementing preventive medical measures. It is essential to recognize that both early and late complications, such as perforation, obstruction, and fistula formation, can occur, particularly after the ingestion of multiple magnets. Given that metabolic complications or volvulus can develop due to intestinal bypass in cases of intestinal fistulas, surgical repair of these fistulas is recommended.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: R.Ö., A.E.H., Ş.E.; Design: R.Ö., A.K.U., Ö.F.B., Ş.E.; Supervision: R.Ö., Ö.F.B., Ş.E.; Resource: R.Ö., A.E.H., Ş.E.; Materials: R.Ö., A.E.H.,

Ö.F.B.; Data collection and/or processing: A.K.U., A.E.H.; Analysis and/or interpretation: R.Ö., A.E.H., Ş.E.; Literature search: R.Ö., A.E.H., Ş.E., Ö.F.B.; Writing: R.Ö., A.E.H., Ş.E.; Critical review: R.Ö., Ş.E., Ö.F.B.

Conflict of Interest: None declared.

Use of AI for Writing Assistance: Not declared.

Financial Disclosure: The author declared that this study has received no financial support.

REFERENCES

- Silverman JA, Brown JC, Willis MM, Ebel BE. Increase in pediatric magnet-related foreign bodies requiring emergency care. *Ann Emerg Med* 2013;62:604–8.e1. [\[CrossRef\]](#)
- Xie S, Bai J, Huang Y, Lin S, Zhang H, Fang Y, et al. Clinical Characteristics and interventions for ingested magnetic foreign bodies in children: a systematic review and meta-analysis. *Indian Pediatr* 2023;60:397–403.
- Arslan S, Basuguy E, Zeytun H, Okur MH, Aydogdu B, Arslan MS. Jejunoleal perforation and volvulus caused by multiple magnet ingestion. *Acta Clin Croat* 2015;54:96–8.
- Corduk N, Odabas SE, Sarioglu-Buke A. Intestinal perforation caused by multiple magnet ingestion. *Afr J Paediatr Surg* 2014;11:84–6. [\[CrossRef\]](#)
- Gün F, Günendi T, Kılıç B, Celik A. Multiple magnet ingestion resulting in small bowel perforation: a case report. *Ulus Travma Acil Cerrahi Derg* 2013;19:177–9. [\[CrossRef\]](#)
- Cevizci MN, Karadağ CA, Demir M, Dokucu AI. Intestinal perforation due to multiple magnet ingestion: a case report]. *Ulus Travma Acil Cerrahi Derg* 2012;18:192–4. [\[CrossRef\]](#)
- Sahin C, Alver D, Gulcin N, Kurt G, Celayir AC. A rare cause of intestinal perforation: ingestion of magnet. *World J Pediatr* 2010;6:369–71.
- Joo DC, Lee MW, Hong SM, Baek DH, Lee BE, Kim GH, et al. A gastric magnetic foreign body incidentally detected several years after ingestion. *Korean J Gastroenterol* 2023;82:198–201. [\[CrossRef\]](#)
- Hussain SZ, Bousvaros A, Gilger M, Mamula P, Gupta S, Kramer R, et al. Management of ingested magnets in children. *J Pediatr Gastroenterol Nutr* 2012;55:239–42. [\[CrossRef\]](#)
- Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009; 6(7): e1000097. [\[CrossRef\]](#)
- Ali A, Alhindi S. A Child with a gastrocolic fistula after ingesting magnets: an unusual complication. *Cureus* 2020;12:e9336. [\[CrossRef\]](#)
- Surd A, Aldea C, Mironescu A, Gocan H. Transmesocolic double gastro-enteric fistulas due to ingestion of 28 magnets. *J Pediatric Surg Case Reports* 2018;32:85–6. [\[CrossRef\]](#)
- Afzal M, Almakki AA, Abugrain HH, Alsaed MM, Alzahir BS, Sulis NA. Laparoscopic assisted extraction of multiple ingested magnets leading to entero-enteric fistulae- Case report of three patients. *J Pediatric Surg Case Reports* 2022;84:102357. [\[CrossRef\]](#)
- Lawrence KM, Iyer M, Baranwal P, Solomon A, Spigland NA. Magnet ingestion leading to intestinal fistulae, phytobezoar formation, and small bowel obstruction. *J Pediatric Surg Case Reports* 2019;49:101289.
- Munghate GS, Reddy A, Bodhanwala M. Multiple magnetic foreign bodies causing complex intestinal fistula. *J Pediatric Surg Case Reports* 2020;63:101661. [\[CrossRef\]](#)
- Feng Ji Mervin G, Ali AF, Kheng Lincoln Dale LS, Vidyadhar M. Multiple magnet ingestion: Ring-like configuration with multiple intestinal fistulae. *J Pediatric Surg Case Reports* 2020;60:101472. [\[CrossRef\]](#)
- Alkhamisy A. Gastrojejunal fistula caused by magnet beads ingestion in a 2-year-old boy. *J Pediatric Surg Case Reports* 2021;67:101809. [\[CrossRef\]](#)
- Kim Y, Hong J, Moon S. Ingestion of multiple magnets: The count does matter. *J Pediatric Surg Case Reports* 2014;2:130–2. [\[CrossRef\]](#)

19. Al-Saied G, Alsamhy O, Ibrahim M, Al-Malki T, BenMalek R, Khemakhem R, et al. Enteroenteric fistulae after ingestion of multiple magnets in children. *J Pediatric Surg Case Reports* 2021;76:102090. [CrossRef]
20. Nguyen BP, Ahuja N, Barthel ER. Chronic small bowel fistulas, entero-mesenteric fistulas, and entrapped bezoar after ingestion of 2.5-mm magnetic beads. *J Pediatric Surg Case Reports* 2023;89:102542. [CrossRef]
21. Zhang YB, Gao ZG, Xiong QX, Zhang LF, Cai DT, Cai JB. Clinical experience in the treatment of children who swallowed multiple magnetic foreign bodies: A report of five cases. *World J Pediatr* 2017;13:274–7.
22. Romine M, Ham PB 3rd, Yon JR, Pipkin WL, Howell CG, Hatley RM. Multiple magnet ingestion in children. *Am Surg* 2014;80:e189–91.
23. Chavan R, Bachkaniwala V, Takkalkar V, Gandhi C, Rajput S. Endoscopic management of magnet ingestion and its adverse events in children. *VideoGIE*. 2022;7:302–7. [CrossRef]
24. Lorenze A, Downey S, Costello LM, Menchini CB. Gastric mucosa fistula secondary to magnet ingestion. *JPGN Rep* 2020;1:e015. [CrossRef]
25. Dias DDM, Amorim WWS, Rodriguez JER, Cauduro JF, Pena SP, Dias DS, et al. Bowel obstruction in entero-colic fistula associated with magnet ingestion in children at the Amazonas countryside. *AME Case Rep* 2019;3:44. [CrossRef]
26. Taher H, Azzam A, Khowailed O, Elseoudi M, Shaban M, Eltagy G. A case report of an asymptomatic male child with multiple entero-enteric fistulae post multiple magnet ingestion. *Int J Surg Case Rep* 2019;58:50–3. [CrossRef]
27. Zachos K, Panagidis A, Georgiou G, Alexopoulos V, Sinopidis X. Double jejunoileal fistula after ingestion of magnets. *J Indian Assoc Pediatr Surg* 2019;24:63–4. [CrossRef]
28. Phen C, Wilsey A, Swan E, Falconer V, Summers L, Wilsey M. Non-surgical management of gastroduodenal fistula caused by ingested neodymium magnets. *Pediatr Gastroenterol Hepatol Nutr* 2018;21:336–40.
29. Blevrakis E, Raissaki M, Xenaki S, Astryrakaki E, Kholcheva N, Chrysos E. Multiple magnet ingestion causing intestinal obstruction and entero-enteric fistula: Which imaging modality besides radiographs? A case report. *Ann Med Surg (Lond)* 2018;31:29–33. [CrossRef]
30. Cherchi V, Adani GL, Righi E, Baccarani U, Terroso G, Vernaccini N, et al. Ileocecal fistula caused by multiple foreign magnetic bodies ingestion. *Case Rep Surg* 2018;2018:7291539. [CrossRef]
31. Merchant S, Stringel G, Rosencrantz RA. Intra-gastric fistula after multiple sphere magnet ingestion. *Clin Gastroenterol Hepatol* 2017;15:e105–6. [CrossRef]
32. Pogorelić Z, Borić M, Markić J, Jukić M, Grandić L. A Case of 2-year-old child with entero-enteric fistula following ingestion of 25 magnets. *Acta Medica (Hradec Kralove)* 2016;59:140–2. [CrossRef]
33. Kisku S, John T, Mutt N. Perils in the playpen: Duodenojejunal fistula in a child following ingestion of two toy magnets. *Trop Gastroenterol* 2015;36:118–20. [CrossRef]
34. Pederiva F, Daniela C, Scarpa MG, Guida E, Dragovic D, Martellosi S. An asymptomatic multiple magnet ingestion with transmesenteric entero-enteric fistula. *APSP J Case Rep* 2014;5:16.
35. Macedo M, Velhote MC, Maschietto RF, Waksman RD. Intestinal fistula after magnets ingestion. *Einstein (Sao Paulo)* 2013;11:234–6. [CrossRef]
36. Kosut JS, Johnson SM, King JL, Garnett G, Woo RK. Successful treatment of rare-earth magnet ingestion via minimally invasive techniques: a case series. *J Laparoendosc Adv Surg Tech A* 2013;23:405–8. [CrossRef]
37. Tsai J, Shaul DB, Sydorak RM, Lau ST, Akmal Y, Rodriguez K. Ingestion of magnetic toys: report of serious complications requiring surgical intervention and a proposed management algorithm. *Perm J* 2013;17:11–4.
38. Wooten KE, Hartin CW Jr, Ozgediz DE. Laparoscopic diagnosis of magnetic malrotation with fistula and volvulus. *JLS* 2012;16:644–6.
39. Clarke R, Everett T, Watts A, Qureshi T. The magnetism of surgery: small bowel obstruction in an 8-year-old boy. *BMJ Case Rep* 2010;2010:bcr0120102667. [CrossRef]
40. Ahmed AM, Hassab MH, Al-Hussaini AA, Al-Tokhais TI. Magnetic toy ingestion leading to jejunocecal fistula in a child. *Saudi Med J* 2010;31:442–4.
41. Shah SK, Tieu KK, Tsao K. Intestinal complications of magnet ingestion in children from the pediatric surgery perspective. *Eur J Pediatr Surg* 2009;19:334–7. [CrossRef]
42. Saeed A, Johal NS, Aslam A, Brain J, Fitzgerald RJ. Attraction problems following magnet ingestion. *Ann R Coll Surg Engl* 2009;91:W10–2.
43. Kabre R, Chin A, Rowell E, Browne M, Barsness KA, Luck S, et al. Hazardous complications of multiple ingested magnets: report of four cases. *Eur J Pediatr Surg* 2009;19:187–9. [CrossRef]
44. Palanivelu C, Rangarajan M, Rajapandian S, Vittal SK, Maheshkumaar GS. Laparoscopic retrieval of "stubborn" foreign bodies in the foregut: a case report and literature survey. *Surg Laparosc Endosc Percutan Tech* 2007;17:528–31; discussion 31–2. [CrossRef]
45. Vijaysadan V, Perez M, Kuo D. 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. *J Am Board Fam Med* 2006;19:511–6. [CrossRef]
46. Uchida K, Otake K, Iwata T, Watanabe H, Inoue M, Hatada T, et al. Ingestion of multiple magnets: hazardous foreign bodies for children. *Pediatr Radiol* 2006;36:263–4. [CrossRef]
47. Liu S, de Blacam C, Lim FY, Mattei P, Mamula P. Magnetic foreign body ingestions leading to duodenocolonic fistula. *J Pediatr Gastroenterol Nutr* 2005;41:670–2. [CrossRef]
48. Nui A, Hirama T, Katsurumaki T, Maeda T, Meguro M, Nagayama M, et al. An intestinal volvulus caused by multiple magnet ingestion: an unexpected risk in children. *J Pediatr Surg* 2005;40:e9–11. [CrossRef]
49. Ohno Y, Yoneda A, Enjoji A, Furui J, Kanematsu T. Gastroduodenal fistula caused by ingested magnets. *Gastrointest Endosc* 2005;61:109–10.
50. Chung JH, Kim JS, Song YT. Small bowel complication caused by magnetic foreign body ingestion of children: two case reports. *J Pediatr Surg* 2003;38:1548–50. [CrossRef]
51. Lee SK, Beck NS, Kim HH. Mischievous magnets: unexpected health hazard in children. *J Pediatr Surg* 1996;31:1694–5. [CrossRef]
52. Kubota Y, Tokiwa K, Tanaka S, Iwai N. Intestinal obstruction in an infant due to magnet ingestion. *Eur J Pediatr Surg* 1995;5:119–20. [CrossRef]
53. Honzumi M, Shigemori C, Ito H, Mohri Y, Urata H, Yamamoto T. An intestinal fistula in a 3-year-old child caused by the ingestion of magnets: report of a case. *Surg Today* 1995;25:552–3. [CrossRef]
54. Hwang JB, Park MH, Choi SO, Park WH, Kim AS. How strong construction toy magnets are! A gastro-gastro-duodenal fistula formation. *J Pediatr Gastroenterol Nutr* 2007;44:291–2. [CrossRef]
55. Quezada H, Levine AE, Dellinger M, Rice-Townsend S, Zheng HB. Esophagogastric fistula: the consequence of high-powered magnets ingestion. *JPGN Rep* 2023;4:e385. [CrossRef]
56. Kumar S, Ghani A. Complications related to unwitnessed magnet ingestion in paediatrics: Case series. *J Pak Med Assoc* 2024;74:175–7. [CrossRef]
57. Hernández Anselmi E, Gutiérrez San Román C, Barrios Fontoba JE, Ayuso González L, Valdés Dieguez E, Lluna González J, et al. Intestinal perforation caused by magnetic toys. *J Pediatr Surg* 2007;42:E13–6.
58. Mandhan P, Alsalihi M, Mammoo S, Ali MJ. Troubling toys: rare-Earth magnet ingestion in children causing bowel perforations. *Case Rep Pediatr* 2014;2014:908730. [CrossRef]
59. İlçe Z, Samsun H, Mammadov E, Celayir S. Intestinal volvulus and perforation caused by multiple magnet ingestion: report of a case. *Surg Today* 2007;37:50–2. [CrossRef]
60. Miyamoto R, Okuda M, Kaneko K, Numoto S, Okumura A. Multiple magnets ingestion followed by intestinal fistula with mild symptoms. *Glob Pediatr Health* 2019;6:2333794X19855805. [CrossRef]
61. Brown JC, Otjen JP, Drugas GT. Pediatric magnet ingestions: the dark side of the force. *Am J Surg* 2014;207:754–9. [CrossRef]
62. Akay MA, Gül S. Çocuk yaş grubunda çoklu mıknatıs yutulması; derleme. *Kocaeli Med J* 2020;9:20–6. [CrossRef]

OLGU SUNUMU VE SİSTEMATİK DERLEME

Çoklu mıknatıs yutulmasına bağlı kronik jejuno-kolonik fistül ve intestinal malabsorbsiyon: Olgu sunumu ve sistematik inceleme

Rahşan Özcan,¹ Ali Ekber Hakalmaz,¹ Ayşe Kalyoncu Uçar,² Ömer Beser,³ Şenol Emre¹

¹İstanbul Üniversitesi-Cerrahpaşa, Cerrahpaşa Tıp Fakültesi, Çocuk Cerrahisi Anabilim Dalı, İstanbul, Türkiye

²İstanbul Üniversitesi-Cerrahpaşa, Cerrahpaşa Tıp Fakültesi, Radyoloji Anabilim Dalı, İstanbul, Türkiye

³İstanbul Üniversitesi-Cerrahpaşa, Cerrahpaşa Tıp Fakültesi, Çocuk Gastroenteroloji Anabilim Dalı, İstanbul, Türkiye

Çocuklarda mıknatıs yutulması akut ve kronik dönemde ciddi komplikasyonlara yol açabilen bir durumdur. Amacımız çoklu mıknatıs yutma hikayesi olan ve geç dönemde jejuno-kolonik fistül, bağırsakta segmental volvulus, hepatosteatoz, renal kalkül saptanan bir olguda tedavi yaklaşımını sunmak ve mıknatıs yutulmasına bağlı oluşan intestinal fistüllerin özelliklerini saptamak için literatür taraması yapmaktır. Çocuk gastroenteroloji bölümüne iki yıldır aralıklı karın ağrısı, kusma ve ishal atakları ile başvuran 6 yaşındaki kız çocuğu Çölyak hastalığı, kistik fibrozis, enflamatuvar bağırsak hastalığı ve tüberküloz ön tanılarıyla araştırılmış, ancak etyoloji saptanamamıştı. Magnetik rezonans görüntüleme jejunokolonik fistül şüphesi olması nedeniyle çocuk cerrahisine konsülte edildi. Fizik muayenede akut batin bulgusu saptanmadı, hafif batin distansiyonu mevcuttu. Üst gis pasaj ve lavman opak grafisinde jejunokolonik fistül ve segmenter volvulus saptandı. Aile tekrar sorgulandığında, hastanın 2 yıl önce mıknatıs yuttuğu, 1-2 hafta içinde mıknatısların kendiliğinden dışarı atılması üzerine başka bir merkezde takibe son verildiği bildirildi. Volvulus ve geniş jejunokolonik fistül nedeniyle cerrahi eksplorasyon yapıldı, segmenter volvulus düzeltildi ve jejunokolonik fistül onarıldı. Literatürdeki çalışmaları belirlemek için, PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) kılavuzlarına göre mıknatıs alımı ve gastrointestinal fistül hakkında ayrıntılı bir araştırma yapıldı. Akut dönemde bulgu vermeyen, akut batin tablosuna yol açmayan 55 olgu (44 makale) saptandı. Olguların 29'unda mıknatısın yutulma zamanı bilinmiyordu. Yabancı cisim yutma zamanı bilinen 26 olguda fistül saptanma zamanı ortalama 22,8 gün (1-90 gün) idi. Kırkyedi olguda laparotomi ile fistül onarımı yapılmıştı. Çocuklarda mıknatıs yutulması sonrası asemptomatik olguların varlığı, akut ve kronik dönemde intestinal fistüllerin oluşabileceği unutulmamalıdır.

Anahtar sözcükler: İntestinal volvulus; jejunokolonik fistül; mıknatıs yutma.

Ulus Travma Acil Cerrahi Derg 2024;30(5):361-369 DOI: 10.14744/tjtes.2024.50845