

# Çocuk Yaş Grubunda Çoklu Mıknatıs Yutulması; Derleme

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### ÖZET

Yabancı cisim aspirasyonu çocuklarda sık görülen bir problemdir. Çoğu olay sadece takip ve gözlem ile kendi kendine çözülür. Ancak, muhtemel komplikasyonlar sebebiyle mıknatıs aspirasyonu daha kompleks ve detaylı bir değerlendirme gerektirir. Birden çok mıknatısın yutulması veya bir mıknatıs ile metalik bir başka cismin beraber yutulması en tehlikeli yabancı cisim aspirasyonlarından. Gelişimini tamamlamamış bağırsakta perforasyona yol açabilir. Tedavide endoskopik çıkarma, operatif çıkarma veya gözlem tercih edilebilir. Bu seçimde yutulan cismin sayısı ve lokasyonu belirleyici faktörlerdendir. Devletler, mıknatıs yutularını önlemek için bir dizi önlemler almışlardır. Bu önlemler, yutma olaylarında düşüşe yol açmıştır. Ölümcül sonuçları olabilecek komplikasyonları göz önüne alarak, doktorların hem birinci basamakta hem de daha ileri merkezlerde, mıknatıs yutularını mutlaka ayırıcı tanıda düşünmeleri gerekmektedir.

**Anahtar Kelimeler:** Mıknatıs yutulması, barsak perforasyonu, fistül oluşumu.

### ABSTRACT

Foreign body ingestion is a common problem in pediatric population. Most of the ingestions may be managed expectantly. However, magnet ingestions require more complex and careful evaluation due to possible severe complications. Multiple magnet ingestions or ingestion of a magnet with another metal object is the most dangerous type and may lead to perforation of immature bowel of the children. Management includes endoscopic removal, surgical removal or expectant management depending on the location and number of magnets ingested. Preventive measures have been put into effect by some governments in the past. The number of cases is in a declining trend. Due to serious outcomes, physicians should keep the magnet ingestion in differential diagnosis in both primary or advanced care centers.

**Keywords:** Magnet ingestion, bowel perforation, fistula formation.

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## INTRODUCTION

Foreign body ingestion is a common problem in pediatric population. In the United States, approximately 70.000 cases are reported annually in children who are 5 years old or younger (1). In Turkish population, foreign body ingestion as a common problem but the epidemiologic data is lacking. The ingested objects may be in various shapes, sizes and characteristics. Most of them pass spontaneously and require no intervention other than observation (2). 10-20% of the cases require endoscopic removal and only 1% require surgical intervention (3). However, batteries and magnets pose unique threats to the well-being of the patient and may manifest with very severe symptoms and complications, thus evaluated differently. In this review, epidemiology, clinical presentation, management and preventive strategies of magnet ingestion are discussed.

### Epidemiology:

In the last 30 years, the use of magnets in daily life has been constantly increasing. Alongside the practicality and beneficial features of the magnets, there is a downside. Magnets may cause serious complications in case of ingestion. Due to their small size and shiny nature, they prompt young children to explore and often to swallow them. Epidemiology of magnet ingestion may be evaluated in 2 parts. The first part is until the year of 2012, before the regulations on magnet use in household objects and toys. The trends differ significantly after that point. We will discuss the pre-regulation period first.

The first report of magnet ingestion dates to 1995 (4). From 1995 to 2012 the number of magnet ingestions had been increasing steeply. A study by Abbas et al. states that between 2002 and 2011, total number of pediatric emergency department visits due to foreign body ingestions was 588,226. 16,386 of them were due to suspected magnet ingestion. In 2002, estimated number of magnet ingestion was 327, while this number rose to 2770 in 2011. Except a slight decrease noted from 2007 to 2009, there is a constantly increasing trend of

ingestions. At the end of the 10-year period, the rate was 8.5 fold increased. During this time period, same study reports that 59.4% of the patients were boys and 54.7% of the patients were younger than age of 5. Also, multiple magnet ingestions were more common in children older than 5 years of age (5).

Another study that analyzes 441,735 pediatric emergency department visits in US between 2010-2015 shows that the total number of magnet ingestion related visits was 14,586. 8,326 of these visits was in 2010-2012 period, before the regulations. 6,260 of them was between 2013 and 2015. 24,8% decrease in emergency visits is noted and the numbers prove the effectivity of the regulations. The declining trend is also applicable for multiple magnet ingestions. The US estimate before the regulation was 2,481 and this estimate decreased by 32,3% to 1,679 after the regulations (6).

Patient characteristics slightly differ between the studies. One study with 56 patients by Brown et al. reported that only the 33,9% of the patients were under the 5 years of age and 50% of the patients were male. This study also shows that 25% of patients had psychiatric diagnoses including Autism (5.4%), Attention deficit hyperactivity disorder, developmental disability, behavioral issues and history of pica (7).

Another study by Oestreich identified 128 magnet ingestions in 21 countries. 92 (71%) of the patients were identified as male and the median age was reported as 6. Autism was reported in 12 of these patients. In addition to autism, ADHD, developmental delay, pica, schizoid personality disorder, Angelman syndrome, repeated inappropriately swallowing of objects, compulsive chewing, behavioral problems, neurosis, 4p-syndrome, congenital hydrocephalus, reactive attachment, anxiety and mental retardation were also reported in these cases (8).

Another study from 2 hospital reports 89 patients with magnet ingestion between January 2011 and June 2016. The median age was 7.9 and 56% of the patients were boys (9).

One study from Istanbul University reported only 1 (0.22%) case of magnet ingestion among 435 patients who were treated invasively for foreign body ingestion. No further data was found for Turkish population (10). However, abundance of case reports may suggest that magnet ingestion is a common problem in Turkish population too.

There are a lot of sources of ingestions reported. These include magnetic components of necklaces, alphabet learning tools, magnet backed faux earrings or piercings, small industrial magnets, magnets from board games, magnet associated office organizers, refrigerator magnets, desk toys and bracelet pieces (8).

In the literature, epidemiologic data is insufficient/limited in some parts of the world. Notably, there were no cases reported from Africa.

#### Pathophysiology of damage:

As stated above, most of the foreign bodies pass without any intervention. But the magnet ingestion, especially multiple magnet ingestion or ingestion of a magnet with another metal object pose a great danger. Normally, if the foreign bodies are not sharp or stuck in an anatomic position, they pass with no trouble. However, the magnets do not pass easily despite their usually smaller sizes. Due to their magnetic natures, they tend to attract each other. If the magnets manage to pass the pyloric sphincter and advance to the bowel, there is a great chance that the motility of the bowel will drag them apart. But the magnets inside the lumen will attract each other from the different segments of bowel and they may merge again with a piece of bowel tissue between them (11). The usually small diameter of the magnets increases the local pressure on the tissue and may lead to necrosis due to insufficient blood supply in arteriolar level. Once commenced, the necrosis progresses rapidly and leads to perforation or fistula formation (4,12). Even though some authors suggest expectant management if the magnets are passing through the bowel as a one merged object, others reject this suggestion. They state that the risk of separation inside the lumen is always present and should not be underestimated (13).

Also, it should be noted that the development of high-powered neodymium-iron-boron magnets in 1982 increased the risk of adverse outcomes (14). Compared to the traditional ferrite magnets, these newly developed ones are 5 to 10 times stronger (11).

#### Presentation:

Presentations of magnet ingested children ranges from asymptomatic to septic. Due to severe complications of delayed diagnosis, physicians must be aware of the possibility of magnet ingestion.

Physician should keep in mind that the children may be unattended at the moment of incident or the caregiver may not be aware of the ingestion. Also, older children may deny it intentionally due to embarrassment or fear of social implications. History must be taken with great detail, but a negative history does not rule out the possibility of ingestion (15).

Most common symptom is abdominal pain and irritability (9). Also, depending on the location of ingested object, patients may present with dysphagia, drooling, choking, chest pain and feeding refusal (16). Wheezing, cough, respiratory distress, vomiting and hematemesis are other signs that may be seen on presentation (1). Flu-like symptoms are also reported (17). A portion of patients may also be completely asymptomatic and seek medical attention only if the ingestion is witnessed by the caregiver. The asymptomatic state of the patient may lead to a misdiagnosis or may lead to a false sense of comfort. There is no correlation reported between asymptomatic presentation and better outcomes/lesser complications (14).

Physical examination findings depend on the location of the foreign body and extent of damage. If the complications are developed already, patient may present with signs of peritonitis. Decreased or increased bowel sounds, and voluntary guarding may also be seen (2,18). One interesting method of evaluation is to pass a compass near the abdomen and track the changes in the magnetic field. This technique may help to spot the presence of a magnet (15).

It should be considered that even in the case of perforation, there may be no signs of peritoneal irritation due to omental walling (19). Also, despite the perforation, ileocecal fistulas may remain asymptomatic.

Imaging techniques also play a big role in the diagnosis. Bedside abdominal ultrasound or upright abdominal x-ray are easy to perform and helpful. Metallic objects appear hyperechogenic and with ring down artifact in ultrasound (20). Also, possible ileus due to the foreign object may be diagnosed. Reported ultrasound findings include presence of free gas, gas fluid levels, dilated bowel loops and foreign body surrounded by inflammation (2).

Upright abdominal X-ray reveals metallic objects with high sensitivity. If the image is obtained in one plane, it may often be misleading. Due to radiopaque nature of metallic objects, multiple magnets may align in one line and mislead the physician into ruling out the possibility of multiple ingestions. One reported case describes a 3 years old patient with a single rod-shaped metallic object in the stomach. He was managed expectantly and returned with acute abdomen 3 days later. Laparotomy in that case revealed multiple magnets attached to each other and mislead the physician in the initial X-ray (13). Because of this, ordering X-rays in multiple planes are recommended if one X-ray confirms the presence of a foreign body. Also, in case of a perforation, the upright abdominal X-ray may reveal free air under the diaphragm or distended bowel loops (2). If the suspicion of foreign body is very strong despite negative imaging, chest X-ray may be ordered to detect foreign bodies stuck in esophagus (9). CT scan may also confirm the diagnosis with higher sensitivity, but it is often unnecessary. CT scans ordered for another reason may reveal the object incidentally<sup>14</sup>. Lastly, MRI must be avoided due to possible fatal complications such as overheating or attraction the ingested metallic body. Unfortunately, one institution reported an incident in which an undisclosed high-power magnet ingestion resulted in intestinal perforation in a patient who had undergone MRI for torticollis (5).

Upon identification of the foreign body, consultation with pediatric gastroenterology and

pediatric surgery is recommended<sup>15</sup>. Management depends on the location and number of foreign bodies. If there is a single magnet proximal to pyloric sphincter, endoscopic removal may be performed in order to minimize the complications (9,20). If the single magnet is distal to pyloric sphincter, expectant management in outpatient settings is recommended. Use of oral laxatives is beneficial and aids the passage. Also, caregivers should be advised to remove clothing that contains metals in order to prevent attraction of the ingested bodies.

In case of multiple magnet ingestion, operative management is indicated even if the patient is asymptomatic. One third of the patients with multiple magnet ingestion develop perforation or fistulas even if they have no suggesting signs. Endoscopy, laparoscopy, laparoscopic-assisted mini laparotomy, or laparotomy are the recommended techniques (20).

Intraoperatively, magnets may be detected by using per-operative X-rays or metallic probes that attract magnets. If a fistula is detected, primary closure is indicated. If the necrosis is extensive and beyond repair, bowel resection and primary anastomosis may also be preferred (12). Also, if the foreign bodies are located distally, they may be milked toward the appendix and removed with an appendectomy (7). Surgeon must be alert and look for other possible perforations.

Intraoperative findings include superficial erosions, perforations, local necrosis, compressed mesentery between magnets and internal hernias<sup>8</sup>.

#### Complications:

Clinical course of the patients may be extremely benign, the objects may pass spontaneously and may be expelled with defecation. This rule is applicable if a single magnet is ingested. One study with 56 patients reports that 96% of the single magnet ingested children were discharged from the emergency department and followed up with no complications (7).

However, in some cases, ingestion of multiple magnets or a magnet with a metallic object may lead to serious complications. The most common complication is fistula formation due to bowel

perforation (12). In one study, perforation rate was reported as high as 50% (5). As explained above, bowel structure of children is very prone to perforation and may easily be damaged by the attractions of magnets. The risk of developing complications increases with delay in presentation (20). As stated earlier, if the ingestion is unwitnessed, medical care may be delayed until the complications develop. Also, some parents may hesitate to bring their children in attention to physician, thinking that the objects will pass spontaneously (3). Earlier reports show that interventions 12 hours after the incident may lead to increased rate of complications (20). The feared outcomes include ischemia, necrosis, perforation, fistulization, hemorrhage, intestinal obstruction, intussusception and volvulus (18,9,17). In other acute or chronic diseases of abdomen, fistula formation generally occurs in weeks. However, in multiple magnet ingestion, fistula formation as early as 5th day post-ingestion has been reported. In one study, resection of intestine was reported in 16.7% of the cases. In the same study, 4.5% of the patients required multiple surgeries (17).

There is only one reported mortality due to multiple magnet ingestion and following sepsis (20).

Also, timing and severity of complications are probably associated with the number of magnets ingested and strengths of these magnets. Ingestion of more than one magnet is associated with higher rate of complications, as expected. In addition to this, newly engineered magnets that contain iron, boron and neodymium powders are nearly 10 times more powerful than the old-fashioned plain iron magnets and are capable of attracting each other through up to 6 layers of bowel wall. They are also strong enough to reposition the bowel (1,11).

Prevention:

Surely the easiest way to avoid the complication is not to ingest magnets at the first place. Primary prevention is the most effective way to prevent complications. As stated above, immense number of children ingest foreign bodies and a significant percent of this number comes in form of magnet ingestions. Physicians should advise the caregivers not to leave small parts of toys near children unattended. Also, mommy bloggers may increase

the society's awareness on this topic. Parents and caregivers should be informed about the possible outcomes of the ingestions and they should be encouraged to seek medical care in such incidents (13).

Also, parents should be advised to dispose toys and office/household utilities that contain magnets. If not disposed, they should be kept out of the children's reach. For older children, fake piercings pose another danger. Parents and children should be counseled about the possible adverse outcomes<sup>15</sup>.

State mandated progress was also achieved in this area in the past decade. In US, Consumer Product Safety Commission (CPSC) and in Canada, Health Canada have taken actions (17).

After a report shows sharp increase in magnet ingestion in children, consumer safety organizations and governmental tools imposed new rules to restrict the availability of magnets. CPSC issued a warning for the first time in 2006, emphasizing the dangers of magnetic toys. This intervention prompted some distributors to recall their products initially but the new toys that contain magnets were introduced shortly afterwards (2). Increased production of magnet containing household and office utilities caused an increase in magnet ingestions. In response to this, in the year of 2011, CPSC determined that magnets that are marketed for children are not compliant with the international standards. Changing the labels and targeting adult consumers were advised to companies. Most of the producers withdrew their products from the market voluntarily. In 2012, CPSC released another statement that bans all toys that contain more than one small magnet unless the magnet has a flux index of 50 kG<sup>2</sup> mm<sup>2</sup> or less<sup>6</sup>. The final regulation was release in 2014 and put into effect in 2015 (14).

Also, CPSC established a hotline that consumers can report unsafe practices or ingestions (15).

Conclusion:

Foreign body ingestion is a common problem in pediatric patients. Curious nature of the child prompts them to explore their surroundings. Shiny, small and tricky magnets are also tempting objects.

It is not easy to detect a possible ingestion if the incident is not witnessed. Signs and symptoms of magnet ingestion is very nonspecific.

Once ingested, magnets may cause severe problems. If the ingestion is unwitnessed or if the parents hesitate to bring the children to medical attention, delay in the treatment may lead to severe complications.

The most common symptom is abdominal pain and irritability. However, some cases may present totally asymptomatic. Patient's state at the time of presentation is not a reliable clue about the clinical course. Because even the asymptomatic patients may develop severe complications. Threshold of suspicion must be low, and physician should always consider this possibility in case of an unexplainable abdominal pain.

Upright abdominal X-ray and ultrasound of the abdomen are very helpful in diagnosis. Once diagnosed, the progress is closely associated with the number of magnets ingested and time passed until diagnosis. Single magnets usually pass without any problems. However, multiple magnet ingestions usually cause complications and should be removed with endoscopic or surgical intervention.

It should be noted that even after the recall and regulations, only the 10% of the magnets were returned. There are still a lot of household objects that pose the risk of ingestion. Parents and caregivers should be educated, and the ingestions should be prevented. Due to the very low prevalence (0,01% in all emergency visits<sup>2</sup>), possibility of magnet ingestion may be neglected. Physicians should be reminded about the possibility of magnet ingestion when the patient presents with abdominal pain or other non-specific symptoms.

In multiple magnet ingestion, early removal is advised. Waiting for spontaneous passage may lead to devastating consequences. Expectant management may be preferred in single magnet ingestions.

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