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Case study

Pediatric Ingestion of Rare Earth Magnets

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Abstract

Ingestion of Fidget toys, such "Bucky Balls" which are rare earth magnets, have become an increasing danger to the pediatric population. From 2002 to 2011, there was an eight-fold increase in emergency department (ED) visits due ingestion of foreign bodies [1]. The hospitalizations and health interventions prodded the US Consumer Product Safety Commission to declare toys made from rare earth elements to be a health risk in 2013. With the increasing number of these rare earth magnet toys being ingested, it is important for nursing staff to be educated on the dangers that could arise. As nursing staff, it is important to understand the anatomy of the GI tract as well as being able to identify ways to advise the parent with signs and symptoms of a potential magnet ingestion. These are all important aspects of parent/patient teaching implications that can be given by hospital staff.

Educational Objectives

Upon completion of this course, the nurse should be able to:

- Understand the dangers of the rare earth magnets when ingested.
- Learn the importance of follow-up abdominal x-rays.
- Gain a better understanding of the anatomy within the GI tract.
- Discover effective strategies for parent teaching methods associated with the rare earth magnet toys.

Introduction

Rare earth magnet toys are considered a creative or fidget toy. Fidget toys by definition are self-regulation tools to help with focus, attention, calming, and active listening [2]. Many sources on these toys state that they improve children's imagination and are a fun way to learn the basics of geometry and architecture. Unfortunately, these toys can be quite dangerous if swallowed and can lead to serious injury, especially if there is a delay in medical treatment. Most of the brand name products of these rare earth magnet toys are recommended for ages 14+. There is a warning label on the outside container that states:

"WARNING! Not intended for ages under 14. Keep Away from children. This product contains magnets. Magnets sticking together or becoming attached to a metallic object inside the human body can cause serious or fatal injury. Seek immediate medical help if magnets are swallowed or inhaled [3]."

Data was compiled from the U.S. National Electronic Injury Surveillance System and reported that from 2009 to 2019, 37,000 kids under the age of 18 were taken to the emergency department for swallowing rare earth magnets [4]. Although some of the rare earth magnets can be passed on their own with the help of laxatives, most require a surgical type of procedure to remove them, especially if more than one is swallowed. Not only is this a serious medical issue, but the child is also receiving additional radiation from imaging and possible surgery under anesthesia.

Background and Prevalence

The immediate threat of magnet ingestion (particularly the high-strength magnets made of neodymium) include the risk of these ingested magnets to become attracted to each other across gastrointestinal walls [5]. Swallowing a single magnet is unlikely to cause significant harm, however, when multiple magnets are swallowed, the magnets can attract each other through the loops of bowel. This can lead to a volvulus, which can compromise the bowel's blood supply and lead to necrosis, perforation, ulceration and sepsis [6]. A volvulus is an abnormal twisting of a part of the large and small intestine and may present as GI symptoms such as vomiting (especially green bile), nausea, abdomen distention, constipation, bloody stools and pain/tenderness [7].

Rare earth magnets, also known as neodymium magnets are made up of an alloy composed of iron, boron and neodymium [8]. Most "Bucky Balls" Fidget toys are made up of neodymium, which is the strongest rare earth magnet. These toys are small 3-6mm round powerful magnets. Invented by General Motors and Sumitomo Special Metals in 1982, neodymium magnets are at least 5 to 10 times stronger than traditional magnets [8]. Neodymium magnets are graded by their magnetic strength [3]. The

grades of these magnets are rated as N35, N40, N42, N48, N50, and N52; the higher the number, the more strongly magnetized. The magnets that were swallowed in this case study were N50, which is considered highly magnetized.

The incidence of magnet ingestion has become a childhood health risk in recent decades, augmented by the rise in very powerful rare earth magnets marketed as toys and kitchen gadgets. From 2002 to 2011, there was an eight-fold increase in emergency department (ED) visits [1]. The hospitalization and health interventions prodded the US Consumer Product Safety Commission to declare toys made from rare earth elements to be a health risk in 2013. The recall however was lifted in 2016 by the Tenth Circuit Court of Appeals in Colorado. In the years from 2013 to 2016, magnet ingestion decreased by almost 80%, but following the overturned ban, cases have started to rise [9].

Treatment and Diagnosis

The preferable detection method would be plain film radiography (or X-Ray); especially given the patient population is most likely to be pediatric. This is of course preferable to computed tomography and fluoroscopy due to patient radiation dose. Magnetic resonance imaging would be contraindicated, as the ingested magnet could be dislodged and potentially cause further damage [10]. Once diagnosed, the physician will prescribe laxatives in hopes the magnets will pass on their own. Typically, these magnets are not recommended to remain in the GI tract for longer than a few days as this can cause necrosis to the colon.

If the magnets do not pass on their own, then a procedure to remove the magnets will be scheduled. Once the magnets are removed it is important to make sure the patient has normal bowel movements without pain. Most often, there is no follow-up needed if the patient returns to normal bowel movements.

Case Study

A six-year-old boy presented to the emergency department (ED) with his mother stating the patient swallowed two rare earth magnets the previous night (See Figure 1 Magnet Size Comparison). He presents with no abdominal pain and has no past medical history. Upon arrival to the ED, an abdominal x-ray was ordered. The x-ray was performed to include the entire GI tract since it was unsure where the foreign body was located. The results of the x-ray revealed that the two magnets appeared to be stuck together and located in the right lower quadrant per the radiologist report. (See Figure 2 First KUB X-Ray). After further evaluation, the radiologist recommended the patient obtain a Computed Tomography of the pelvis. The CT pelvis was to confirm that there was not any bowel tissue in-between the two magnets that could potentially cause damage to the intestines. Luckily, the results of the CT revealed there was not any tissue in-between the two magnets (See Figure 3 CT Pelvis). The patient was prescribed Miralax (laxative) in hopes that he would pass the magnets through his stool. It was also recommended that the patient have a bowel movement collected in a specimen container in order to confirm passing of the magnets.

Figure 1: Magnet size comparison of the two magnets swallowed.

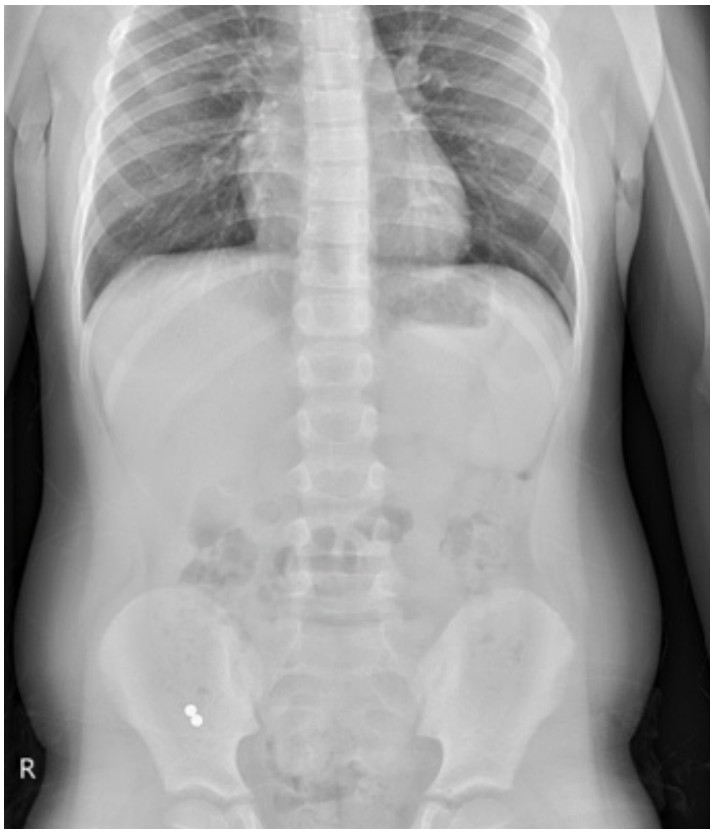

Figure 2: 1st Abdominal X-Ray about 15 hours after ingestion.

Figure 3: CT Axial Pelvis about 15 hours after ingestion.

The next morning the patient had one bowel movement only and no magnets were seen in the specimen container. The patient's mother contacted the pediatrician and it was recommended to get another KUB x-ray to see if the magnets had moved. The patient was taken to the local hospital for an outpatient x-ray. The results of this KUB x-ray showed no movement of the magnets from the prior x-ray and they remained in the ascending colon (See Figure 4 Second KUB X-ray). The pediatrician then referred the patient to a pediatric gastroenterologist. That same day, the patient saw the pediatric gastroenterologist and she too recommended another KUB x-ray since it had been about 8 hours since the last KUB x-ray. Unfortunately, the patient had only experienced one bowel movement since swallowing the magnets. Again, this KUB revealed the magnets were still in the cecum. The Pediatric Gastroenterologist recommended that the patient go home with stronger laxatives and come back in the morning to acquire another KUB.

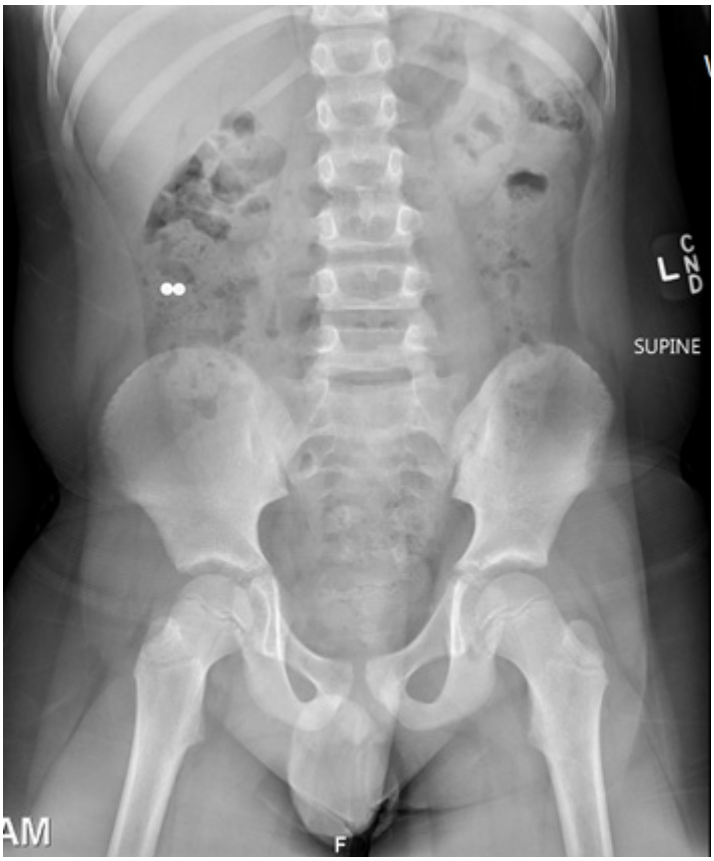

Figure 4: 2nd Abdominal X-Ray about 36 hours after ingestion and where the magnets remained until they were surgically removed.

The following morning, the patient did not have a bowel movement after taking stronger laxatives and this KUB too, confirmed the magnets had still not moved. The Pediatric Gastroenterologist recommended the patient be admitted to the hospital where he could be monitored and given another night of stronger laxatives in hopes that he would pass the magnets. It was decided, that after one more day of laxatives, if the patient did not pass the magnets then a colonoscopy with net retrieval for foreign body was going to be scheduled. Due to the potential negative effects the magnets could create, the pediatric gastroenterologist did not want them to remain in the patient for longer than a few days.

The patient still did not pass the magnets after being ingested and lodged internally for five days. Many rounds of laxatives were given and the patient had many bowel movements. Unfortunately, the magnets were not seen in the specimen container and it was assumed the magnets did not pass. Another KUB x-ray confirmed the magnets remained in the cecum. The pediatric gastroenterologist planned to schedule the colonoscopy with net retrieval to be done within a six-hour window.

A colonoscopy was performed to remove the rare earth magnets. The patient tolerated the procedure well. Upon removal, it was noted the magnets remained adhered together, and changed position frequently between the ileocecal valve and cecum. Following hospital policy, the patient was discharged to the care of his parents after demonstrating alertness and the ability to eat without incident. Thankfully, the patient had no ill effects from the magnet ingestion.

Nursing Implications: Understanding the Anatomy of the Intestinal Tract

The digestive systems, which includes all organs associated with processing food through the body, begins with the mouth and ends with the rectum. Within this vast system, the body actively breaks down food in digestion to absorb needed nutrients. It is essential that all facets of this tract be working optimally to provide the body with the required nutrients as well as eliminating wastes.

The digestive process begins in the mouth where mastication initiates the physical breakdown of foods, while saliva softens, lubricates, and chemically continues the digestive process [11]. The food bolus continues through the pharynx and esophagus to land in the stomach. The stomach, which is also the most dilated portion of the entire digestive tract, is capable of changing shape to accommodate the amount of food present. Within the stomach, the intensive mucous membrane is responsible for further lubricating the food, as well as continuing the digestion process [4]. This extended digestion occurs with the assistance of gastric juice. Gastric juice, very acidic in nature, kills bacteria, converts pepsinogen to pepsin (responsible for protein use), and regulates the expulsion of food from the stomach, through the pylorus, to the small intestine [11].

The small intestine, comprised of the duodenum, jejunum, and ileum, serve to further the digestive process, by stimulating the function of accessory digestive organs. Of particular note in the small intestine is the actual interior feature. The length of the small intestine is lined with an inner-most mucous membrane, which is arranged in circular folds. This layer, by using the circular folds, increases the area of absorption [12]. A plethora of juices and enzymes actively work within the small intestine to facilitate the digestive process, promoting breakdown of foods and absorption of proteins, fats, and carbohydrates [12].

Once through the small intestine, passage of material continues through the large intestine. The large intestine consists of seven sections starting with the caecum and terminating with the anal canal. Primarily, the large intestine is responsible for the absorption of water and salts, while excreting feces [13]. Because of the nature of the colon, bacteria growth is present.

Joining the ileum of the small intestine to the caecum of the large intestine is the ileocaecal valve. This valve, functioning as a sphincter, serves as a stop-gate to prevent contents from the caecum, or large intestine, to move back into the small intestine via the ileum. The gastroileal reflex, which is initiated when food enters the stomach, causes movement of contents through the ileocaecal valve [14].

Bowel obstructions, when bowel contents are unable to pass through the digestive tract, cause an accumulation of bowel contents above the obstruction. Typically defined as either mechanical, which is caused by an issue outside the intestine or blockages within the interior of the intestine, or nonmechanical, caused by decreased muscle activity within the intestine, these blockages can be partial or complete. Of concern is the possibility of ischemia and necrosis of the bowel as a result of strangulation. Additionally, necrosis can lead to perforation of the bowel, which would allow bowel contents to leak into the peritoneal cavity [15].

Teaching Implications for the Parent and Patient

Because untreated bowel obstruction can lead to bowel necrosis resulting in bowel perforation and sepsis, prompt diagnosis and subsequent treatment is essential. Considering the pediatric population, teaching must occur for both the parent and patient. There are several factors to consider, such as the developmental and health literacy of the learner, as well as preferred learning styles, and teaching strategies supported by evidence-based practice [16].

To begin an effective teaching opportunity, it is essential to assess the developmental and health literacy for both the parent and patient. This can

be achieved by observing behavioral cues, evaluating admission information, and asking direct questions [17]. With this assessment, the goal is to establish the level of understanding for both the patient (if applicable) and parent. Once that level of understanding is identified, teaching can continue in a format most appropriate for the patient. Asking the patient and parent how they best like to learn will provide insight on preferred learning styles. Teaching materials should be age/developmentally appropriate.

Finally, pairing an understanding of developmental and health literacy with techniques best developed for specific learning styles can provide a strategic teaching plan to best meet the needs of the pediatric patient and their parent.

Keeping those learning and teaching concepts in mind, several points should be stressed when discussing ways to minimize the risk of bowel obstruction or recognizing the presence of potential obstruction within the pediatric population. In order to minimize the risk of bowel obstruction, all efforts to decrease the likelihood of a mechanical obstruction should be followed. This would include removing small objects that can easily be swallowed from the area of an infant/toddler to the explanation of the importance of avoiding placing non-edible items in the mouth for older children. Likewise, monitoring the presence and pattern of bowel movements can provide an indication of bowel function. While this may be easier with the infant/toddler, it becomes more challenging with a school-age or adolescent child. Observation may include signs of abdominal discomfort and/or decrease food consumption. Asking direct questions about their last bowel movement may be needed.

Understanding the importance of avoiding foreign object insertion in the mouth can encompass the introduction of germs to the oral cavity, the increased risk for choking and most serious, the potential for volvulus or bowel obstruction. Consistent, clear information provided to both the pediatric patient and their parent will minimize these potential risks [18-29].

Conclusion

It is important for parents and caregivers to be aware of the dangers associated with swallowing these rare earth magnets. Immediate medical attention is necessary in order to follow the magnet's movement throughout the GI tract. If the magnets remain unchanged in their movement, then surgical intervention needs to be considered in order to prevent serious complications and damage to the colon.

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