Archives of Radiology

ISSN: 2638-521X

Volume 2, Issue 2, 2019, PP: 01-07

The Menacing Magnets: A Mimicker of Appendicitis that the General Radiologist should Keep in Mind

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Abstract

Abdominal pain is one of the most common complaints children present with to the emergency department. We present a case of a 5- year- old male who presented to the emergency department with complaints of right lower quadrant abdominal pain. Initial imaging evaluation was performed with ultrasound, as is often the first line for evaluation of acute appendicitis in the pediatric population. By recognizing the imaging findings of small bowel obstruction on ultrasound the radiologist raised concern warranting the need for further imaging evaluation with computed tomography (CT). CT then revealed magnets as being the cause of obstruction and perforation of the bowel. With the focus of reducing radiation exposure in children – it is important for the general radiologist to recognize imaging findings on ultrasound that should prompt further evaluation with ionizing radiation. Furthermore, the general radiologist should keep in mind the ingestion of magnets as an increasing cause of obstruction in the pediatric population.

Keywords: *Foreign body ingestion, Magnets, Pediatric abdominal pain, obstruction.*

Introduction

Abdominal pain and digestive disorders are the 4th most common cause of presentation to the ER in the pediatric population [1]. Children often present with non-specific complaints leading to a wide differential. After ruling out life-threatening conditions that require emergent intervention, one must pay careful attention to the child's historypresence of fever, vomiting, location of abdominal pain and other symptoms [2]. Acute appendicitis remains the most common cause of acute abdominal pain requiring surgery with a peak incidence in school age children and adolescents. However, only 1-8% for children presenting with abdominal pain actually have acute appendicitis [3].

Cumulative radiation exposure is a significant concern in the pediatric population. Pediatric patients are exposed to higher radiation doses than adults due to their smaller anatomy resulting in an overall greater dose to organ ratio even when overall levels of exposure are reduced [4]. Children are also more radiosensitive than adults due to their active growth of cells and turnover [5]. Additionally, there are great number of years in which cancerous changes can occur. Exposure to one CT scan at the age of 5 years old increases risk developing of cancer 5-7x fold when compared to a 30-year-old adult patient [6].

With radiation exposure in consideration, ultrasound has become the first line imaging choicefor the evaluation of acute abdominal pain. Ultrasound is also relative inexpensive when compared to other cross sectional imaging modalities [7]. There is no need for anesthesia as is often necessary when evaluating a pediatric patient with magnetic resonance imaging, thereby obviating the concerns raised by anesthetic exposure in a child [8].

We report a case of a child with complaints of abdominal pain found to have a small bowel obstruction on ultrasound. Follow up imaging revealed magnets being the case for bowel obstruction and perforation.

Case Report

A 5 year old male with no previous past medical history presented to the emergency department with complaints of abdominal pain. The patient's mother

stated that his pain had started two days prior and was accompanied by one episode of emesis. His pain resolved until the day of presentation at which point the patient began to have multiple bouts of emesis. The patient and his mother denied any known ingestion and no one else in the family had similar complaints.

On physical examination by the emergency department provider, the patient's abdomen was soft; however, he exhibited tenderness in the right lower quadrant and epigastric region with rebound and guarding. Vitals revealed a low grade fever of 100.4 degrees F (38.0 degrees C) accompanied by tachycardia (heart rate 134 beats/min), an increased respiratory rate (32) and mild elevation in blood pressure (119/91). Laboratory evaluation demonstrated an increased white blood cell count of 22.0 (normal range 5.5-15.5) with a leftward shift of neutrophils 89.7% (normal range 40-80%). The patient also had an elevated C - reactive protein of 33.94 (0.00-5.00). The remainder of the laboratories were unremarkable.

Given the concern of possible appendicitis, an ultrasound was ordered for further evaluation. Although, the ultrasound did not reveal the appendix, multiple distended loops of hypo-peristalsing small bowel were identified [Figure 1]. Additionally there was a moderate amount of free fluid within the bowel with underdistended loops of adjacent small bowel [Figure 2].

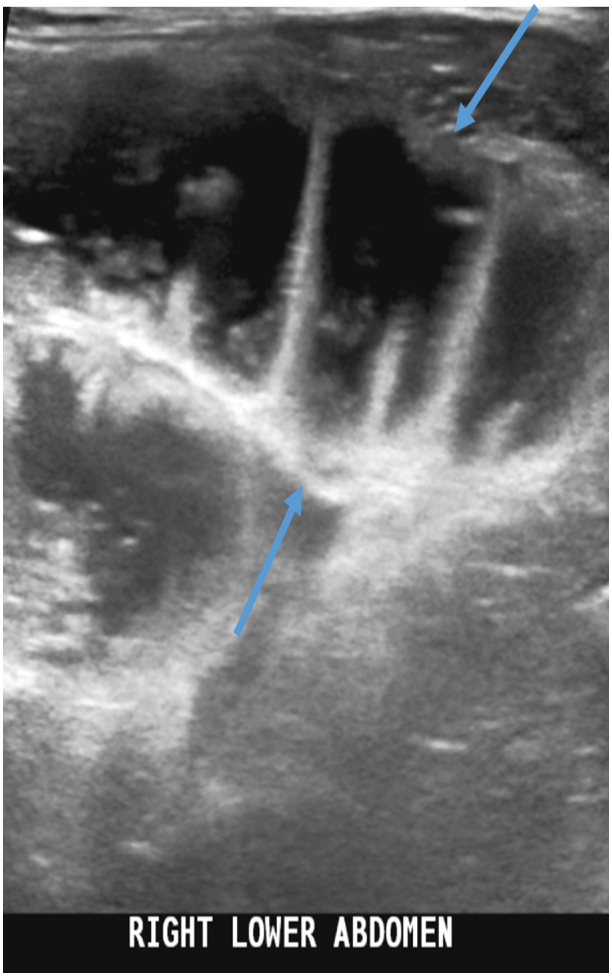

Fig 1. *Sonographic image of the right lower quadrant demonstrating fluid filled dilated loops of small bowel in the right lower abdomen (blue arrows).*

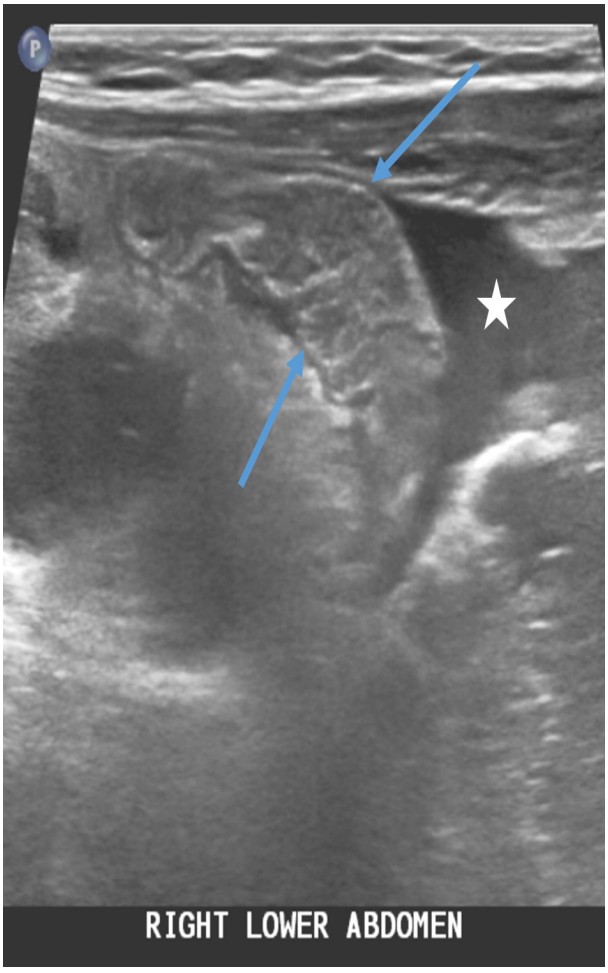

Fig 2. *Sonographic image of the right lower abdomen demonstrating underdistended loops of small bowel (blue arrow) with adjacent free fluid (white star).*

This raised a concern for small bowel obstruction and a CT of the abdomen and pelvis with intravenous contrast was recommended for further evaluation. CT revealed multiple distended loops of bowel as well as multiple locules of free air compatible with small bowel obstruction and perforation [Figures 3 and 4].

Fig 3. *Contrast enhanced coronal CT image demonstrating dilated fluid filled loops of small bowel (blue arrows) and radio-dense foreign objects in the right upper quadrant (red circle).*

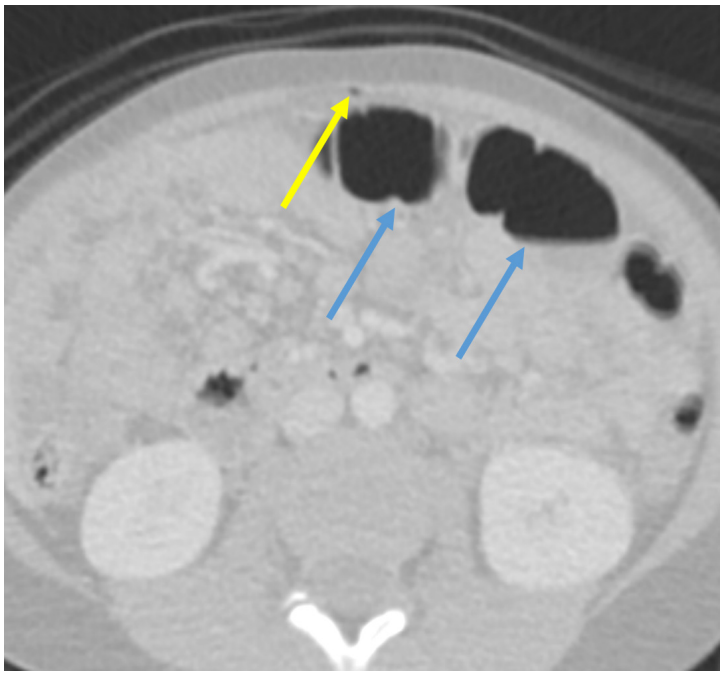

Fig 4. *Contrast enhanced axial CT image with lung algorithm demonstrating air filled dilated loops of small bowel (blue arrows) as well as extra-luminal intraperitoneal free air (yellow arrow) raising concern for perforation.*

The inciting factor was found to be radiopaque round objects lodged in the small bowel within the right upper quadrant of the abdomen, which were best seen on the scout view [Figure 5]. Upon review of the scout image these were determine to be round magnet balls.

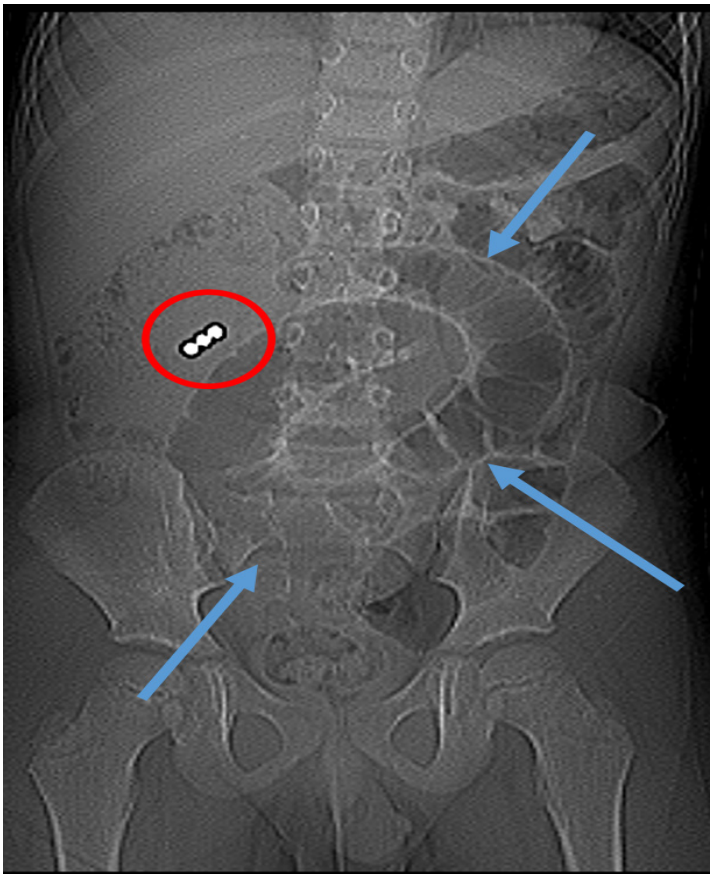

Fig 5. *Coronal Scout Image from CT demonstrated air filled dilated loops of bowel (blue arrows) proximal to three metallic foreign objects (red circle) resulting in an obstructive pattern*

The patient was brought the operating suite and an exploratory laparotomy was performed which revealed perforations in the jejunum as well as in the second and third portion of the duodenum. The foreign bodies could not be palpated initially so fluoroscopy was utilized to locate the foreign bodies. Three round magnet balls were removed from the jejunum and duodenum. The perforation in the bowel were then repaired

A follow – up upper gastrointestinal series was performed [Figure 6] revealing no leak after 4 days post operatively. The patient recovered without complication.

Figure 6: Frontal view from patient's fluoroscopic upper gastrointestinal series performed on post-operative day #4 showing contrast within loops of small and large bowel and an overall non-obstructive pattern. There was no extra-luminal spill of contrast.

Discussion

The ingestion of foreign bodies is common in the pediatric population with most cases involving children between the ages of 6 months to 3 years old [9]. Diagnosing the ingestion of a foreign object can be quite difficult as children can be poor historians or may be unwilling to admit any perceived wrongdoing. Per the National Poison Data System Annual Report, in 2017 nearly 64,000 reports were made of ingestion of a foreign body by a child of5 years of age or younger [10]. Although, the majority of foreign bodies ingested by children pass spontaneously through the gastrointestinal tract, complications can occur. The potential for complication is especially true in the setting of ingested magnets.In 2006, the CDC issued a review of cases of ingested magnets in which complications included intestinal perforation, volvulus with bowel necrosis, and even death [11].

In 2012, the Consumer Product Safety Commission policy action banned the production and sale of all aggregable magnet sets, regardless of type [12]. This did result in a decrease in the number of reported ED visits related to magnet ingestion; unfortunately, this ban was uplifted in 2016 [13]. Even though the court continued the prohibition of sale of magnets intended for entertainment use such as toys, it failed to acknowledge the dangers of magnet found in materials marked for education, industrial or professional media [Reeves]. Since then, complications following the ingestion of magnets continue to be reported in the literature [14,15,16].

Furthermore,newly engineered magnets are known to containmaterials such as boron and neodymium and are said to be 5-10 times stronger than traditional iron magnets [17]. Also known as "rare-earth magnets," these are often found in magnetic building sets and other toys. The strength of the magnetic force becomes very dangerous in the setting of multiple magnet ingestion. After ingestion, magnetic objects may become unattached from one another due to the propulsive force of gut peristalsis. As the magnets progress through the bowel, the attractive magnetic force reattaches the magnets to one another. However, at this point the magnets may be in separate loops of bowel as was seen in our case. This results in the bowel then becoming trapped between the magnets. After sometime, this leads to bowel wall necrosis, perforation and even fistula formation [18]. In our case, the three magnetic balls became separated and were found to be within the jejunum, and the second and third portions of the duodenum. The magnets then through their attraction resulted in three separate foci of perforation as well as bowel obstruction.

When there is a known ingestion, imaging plays an important role in the work up and treatment of the pediatric patient. The first step in imaging is radiography and standard imaging protocol to obtain frontal x-ray of the chest and abdomen. Lateral views can be obtained if there is a need to better localize the foreign object [19]. It is crucial to determine the number of magnets in the setting of magnetic ingestion. A single magnet can be expected to pass spontaneously [9].In the setting of multiple magnet ingestion, CT is then obtained if there is concern for complication such as bowel obstruction or perforation.

As previously mentioned, without a concern for foreign body ingestion, abdominal pain is usually first imaged with ultrasound due its non-ionizing nature. The identification of the sonographic imaging features of bowel obstruction by the radiologist are of the upmost importance in regards to guidance for further cross-sectional imaging. Finding of obstructed bowel on ultrasound include dilated fluid filled loops of bowel. The diameter of these loops should be greater than 3-4 cm and there is usually wall thickening [20]. Additionally, a to-and fro- motion of the bowel contents can be observed on dynamic imaging. Akinesis of a bowel loop is defined as the lack of bowel peristalsis for more than 5 minutes [21]. Ultrasound in the correct setting can also be used to find the transition point or cause of obstruction. Ultrasound has been shown to identify foreign objects and in certain cases their location in bowel [22].

Recognizing the potential for foreign body ingestion when a child comes in with abdominal pain, and more specifically right lower quadrant abdominal pain is very important. In many institutions, evaluation for appendicitis in the pediatric patient after an inconclusive abdominal ultrasound is to follow up with an MRI of the pelvis to identify the appendix. Entering the magnetic field of an MRI scanner could result in movement of the object or heating within the abdomen itself and resulting in further damage and complication [23]. MRI should never be performed in a child without a negative radiograph to ingestion of a metallic foreign object.

It is of the utmost importance that the general radiologist take into account foreign body ingestion, especially that of magnets as a common cause for obstruction in the pediatric population. By identifying this safety hazard, the radiologist can help guide further imaging evaluation and management decisions for the referring pediatric clinicians.

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Citation: **Priya G. Sharma, Patricia L. Abbitt**. *The Menacing Magnets: A Mimicker of Appendicitis that the General Radiologist should Keep in Mind. Archives of Radiology. 2019; 2(2): 01-07.*