Journal of Pediatric Surgery xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Magnet foreign body ingestion: rare occurrence but big consequences☆

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ARTICLE INFO

Article history:
Received 27 June 2017
Received in revised form 2 August 2017
Accepted 7 August 2017
Available online xxxx

Key words:
Magnet ingestion
Foreign body ingestion
Children
Surgery

ABSTRACT

Purpose: To review the outcomes of magnet ingestions from two children's hospitals and develop a clinical management pathway.
Methods: Children < 18 years old who ingested a magnet were reviewed from 1/2011 to 6/2016 from two tertiary center children's hospitals. Demographics, symptoms, management and outcomes were analyzed.
Results: From 2011 to 2016, there were 89 magnet ingestions (50 from hospital 1 and 39 from hospital 2); 50 (56%) were males. Median age was 7.9 (4.0–12.0) years; 60 (67%) presented with multiple magnets or a magnet and a second metallic co-ingestion. Suspected locations found on imaging were: stomach (53%), small bowel (38%), colon (23%) and esophagus (3%). Only 35 patients (39%) presented with symptoms and the most common symptom was abdominal pain (33%). 42 (47%) patients underwent an intervention, in which 20 (23%) had an abdominal operation. For those undergoing abdominal surgery, an exact logistic regression model identified multiple magnets or a magnet and a second metallic object co-ingestion (OR 12.9; 95% CI, 2.4 – Infinity) and abdominal pain (OR 13.0; 95% CI, 3.2–67.8) as independent risk factors.
Conclusion: Magnets have a high risk of requiring surgical intervention for removal. Therefore, we developed a management algorithm for magnet ingestion.
Level of evidence: Level III.

Magnet ingestion and its complications have been well described in the literature [1–6]. Unfortunately, there has been an increase in incidence of magnet ingestions in the past decade [7–9]. In 2014, foreign bodies, including magnets, were the fourth most common ingestion by children less than 5 years old [10].

A significant concern for surgeons is the ingestion of multiple magnets or a magnet and a second metallic foreign body because they have the ability to connect to one another between loops of intestine causing intestinal necrosis, obstruction and perforation [4–6,11]. Recently, there has been evidence that the incidence of ingesting multiple magnets has increased [9]. To better manage this patient population, algorithms have been adopted to guide the management of magnet ingestions [5,12–14]. However, with the recent increase in magnet ingestions, especially multiple magnet ingestions, an updated management pathway is lacking.

The purpose of our study was to review the outcomes of magnet ingestions from two tertiary-care children's hospitals and develop a management algorithm.

1. Methods

1.1. Study design

Following approval by the Institutional Review Board (IRB) of Children's Mercy Hospital (IRB#16070546) and Texas Children's Hospital (IRB#H39198), medical records of all children less than 18-years-old with magnet ingestions were retrospectively reviewed from January 2011 to June 2016. Patients were identified based on International Classification of Disease Ninth Revision (ICD-9) diagnosis coding. Patients diagnosed with foreign body ingestion, which included mouth, esophagus and stomach (935.0, 935.1 and 935.2), intestine and colon (936), and unspecified digestive system (938) were reviewed. Those with magnet ingestions were included and those with non-magnet ingestions where excluded.

1.2. Data collection

Patient demographics including age, gender, and race were collected. Magnet ingestion characteristics including location, symptoms and

☆ All authors have no conflicts of interest to disclose regarding this study.

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http://dx.doi.org/10.1016/j.jpedsurg.2017.08.013
0022-3468/

diagnostic workup were recorded. Clinical management including procedures performed, and complications were included. De-identified data from both institutions were used for data analysis.

1.3. Statistics

Descriptive statistics including counts and percentages were analyzed. Pearson's chi-square and Fisher's exact tests were used for categorical variables, and the frequencies were reported as a percentage of the group of origin. Mann–Whitney *U* test was utilized for continuous variables and frequency of continuous variables was reported as median and interquartile range (IQR). Statistical significance was set at $p < 0.05$, and all reported *p* values are two-tailed. Multivariate logistic regression utilizing the forward stepwise selection method was performed to identify independent predictors of those undergoing abdominal surgery for magnet ingestion. Statistical analysis was performed using IBM SPSS Statistics (Version 23, IBM Corp., Armonk, NY).

2. Results

2.1. Patient characteristics

A total of 89 patients were found to have ingested a magnet (Hospital 1 = 50 and Hospital 2 = 39) (Table 1). The median age was 7.9 (4.0–12.0) years, and there were 56% (n = 50) males. Sixty-seven percent (n = 60) of patients ingested multiple magnets and or a magnet and a second metallic foreign body. The most common location identified on imaging was small intestine and/or colon (45%) followed by the stomach (42%). Only 39% were symptomatic and the most common symptom was abdominal pain.

2.2. Clinical management

Plain radiographs were most often used to confirm the diagnosis, with abdominal radiographs being the most common (64%). Services managing magnet ingestion varied: Surgery (36%), Gastroenterology (GI) (24%), Emergency Department (28%) and Surgery/GI co-management (12%). Fifty three percent of patients were initially managed non-operatively. Non-operative management was commonly performed in the outpatient setting. For those managed non-operatively, 34% received a bowel regimen and 47% underwent serial imaging. However, 28 (37%) patients failed non-operative management and eventually underwent an intervention. A total of 42 (47%) patients underwent an intervention and the median days to intervention was 2 days.

Interventions included endoscopy (50%), abdominal surgery (31%), and combined endoscopy and abdominal surgery (19%). Endoscopic interventions included rigid esophagoscopy (4%), esophagogastroduodenoscopy (55%), and colonoscopy (41%). These endoscopic interventions were successful in retrieving the foreign bodies 66% of the time. There were 10 unsuccessful endoscopies that required abdominal surgery. Findings at the time of endoscopy included five with mucosal irritation. There was no reported perforation, tissue necrosis, or fistula reported at endoscopy. There were no complications from endoscopy.

Additionally, there were 21 patients that underwent abdominal surgery. The majority of patients (65%) undergoing abdominal surgery were approached laparoscopically. Findings at surgery included: perforation (6), fistula (4), midgut volvulus (1), and pressure necrosis (1). Clinical management strategies are summarized in Table 2.

2.3. Variation in management

When comparing the two hospitals there was no significant difference in age, gender, or location of the magnets ($p > 0.05$). However, Hospital 2 utilized CT scans for diagnosis significantly more than Hospital 1. Both hospitals admitted close to 50% of patients for inpatient

Table 1
Patient characteristics.

	Total population (n = 89)
Gender, No. (%)	
Male	50 (56)
Female	39 (44)
Race, No. (%)	
Caucasian	57 (64)
African American	9 (10)
Hispanic	16 (18)
Other	5 (7)
Not Available	2 (2)
Age, years^	**7.9 (4.0–12.0)**
Multiple Magnets or Magnet + metallic foreign body, No. (%)	
Yes	60 (67)
No	29 (33)
Location, No. (%)	
Esophagus	2 (2)
Esophagus and stomach	1 (1)
Stomach	37 (42)
Beyond stomach (small intestine and/or colon)	40 (45)
Combined stomach and beyond stomach	9 (10)
Symptomatic, No. (%)	
Yes	35 (39)
No	54 (61)
Symptoms, No. (%)	
Obstructive symptoms	8 (9)
Abdominal pain	29 (33)
Nausea and vomiting	16 (18)

^ Reported as median (IQR).

Table 2
Clinical management

	Total population (n = 89)
Diagnosis, No. (%)	
Chest X-ray	26 (30)
Abdominal X-ray	57 (65)
Foreign body series (combined chest and abdominal X-ray)	27 (30)
CT	9 (10)
UGI	1 (1)
Admitted, No. (%)	
Yes	44 (49)
No	45 (51)
Managing service, No. (%)	
Surgery	32 (36)
Gastroenterology	21 (24)
Emergency department	25 (28)
Surgery/gastroenterology co-management	11 (12)
Intervention, No. (%)	
Yes	42 (47)
No	47 (53)
Days to intervention^	2 (3)
Type of intervention, No. (%)	
Endoscopy	21 (50)
Abdominal surgery	13 (31)
Endoscopy and abdominal surgery	8 (19)
Type of endoscopy, No. (%)	
Rigid esophagoscopy	1 (4)
EGD	16 (55)
Colonoscopy	12 (41)
Type of abdominal surgery, No. (%)	
Laparotomy	9 (43)
Laparoscopy	12 (57)
Location of non-operative management, No. (%)	
Inpatient	33 (44)
Outpatient	42 (56)
Type of non-operative management, No. (%)	
Bowel regimen	26 (34)
Serial X-rays	36 (47)
Failure of non-operative management, No. (%)	28 (37)

Abbreviations: CT, computerized tomography; UGI, upper gastrointestinal series; EGD, esophagogastroduodenoscopy.
^ Reported as median (IQR).

Please cite this article as: Sola R, et al, Magnet foreign body ingestion: rare occurrence but big consequences, J Pediatr Surg (2017), http://dx.doi.org/10.1016/j.jpedsurg.2017.08.013