Magnetic Foreign Body Injuries: A Large Pediatric Hospital Experience

Matt Strickland, MD, BASc[1,2], Daniel Rosenfield, MD[1,3], and Annie Fecteau, MDCM, MSc[1,2]

Objective To examine trends in magnet-related injuries and hypothesize that changes are a result of new neodymium-iron-boron magnets that are smaller, stronger, and commonly sold in sets.

Study design In this retrospective chart review, we searched our institution's electronic patient record for patients less than 18 years old who were diagnosed with magnetic foreign body ingestion between 2002 and 2012. Cases were analyzed for patient, magnetic foreign body, and management characteristics. Incidence rates and case characteristics were compared between the first 8 years of the study period and the last 3.

Results We identified 94 patients who met our search criteria. Of confirmed ingestions, the median age was 4.5 years and 65% were male. The incidence of visits increased between the 2002-2009 period and the 2010-2012 period by a factor of 2.94 (95% CI, 1.84-4.70), whereas the incidence of injuries involving multiple magnets increased by a factor of 8.40 (95% CI, 3.44-20.56). The volume of the magnets decreased from 878.6 mm^3 to 259.8 mm^3. Six cases required surgical removal of the magnets because of intra-abdominal sepsis or concern for imminent bowel perforation.

Conclusions Since 2002, there has been a significant increase in the incidence of magnetic foreign body injuries. These injuries have increasingly involved multiple, smaller magnets and required operative intervention. *(J Pediatr 2014;165:332-5)*.

Pediatric magnet ingestions have received increasing attention over the past 10 years. Although most smooth, ingested foreign bodies pass innocuously through the gastrointestinal tract,[1] multiple magnets pose the unique danger of being able to attract each other through different loops of bowel, arresting their movement, and potentially causing mural pressure necrosis. This can lead to bowel perforation, fistula formation, volvulus, obstruction, intra-abdominal sepsis, and death.[1-6] With the advent of stronger neodymium-iron-boron magnets and their inclusion as part of children's toys, jewelry, and desk toys, there has been a documented increase[7-9] in the number of cases resulting in serious morbidity[6] and in rare cases, mortality.[4,5]

Injury surveillance data from the US,[4] Canada,[10] and Australia[11] suggested as early as 2006 that this was a developing trend. More recently, 2 groups[7,8] examined data from the US National Electronic Injury Surveillance System and showed that the rate of magnet-related injury had increased dramatically over the period from 2002 to 2011. One large, urban pediatric hospital in the US has published its experience and demonstrated an apparent increase in the number of ingestions and an increasing proportion involving multiple magnets.[12]

The purpose of our study was to examine the epidemiology and temporal trends of magnet-related injury at a large, Canadian pediatric hospital. Where possible, we aimed to examine the type and number of magnets involved to seek evidence on how shifting magnet technology was involved in this evolving injury pattern. We hypothesized that there would have been a significant increase in magnet-related injury from 2002-2012, with a detectable shift toward smaller magnets and ingestions involving multiple magnets. With this, we expected to find an increase in the morbidity associated with these ingestions.

Methods

We performed a retrospective study of all emergency department (ED) visits between April 1, 2002 and December 31, 2012, to a single urban tertiary care pediatric ED with an average annual volume of approximately 55 000 visits over the study period. This included patients referred by community physicians directly to our gastrointestinal, otolaryngology, and general surgery services via the ED. (In these cases, the patients are not assessed by the emergency staff, but are held in the ED until assessed by the consultant services.) Our hospital serves as 1 of 4 acute-care pediatric hospitals in Ontario, Canada, a province of 13.5 million people. It acts as a referral center for all pediatric subspecialties as well as being the local hospital for children living in the surrounding urban neighborhoods.

We identified cases by searching through all ED visits with *International Classification of Diseases, 10th revision* (ICD-10) codes corresponding to foreign

ED	Emergency department
ICD-10	*International Classification of Diseases,10th revision*
IRR	Incidence rate ratio

From the [1]Hospital for Sick Children, [2]Division of General Surgery, and [3]Department of Pediatrics. University of Toronto, Toronto, Ontario, Canada

The authors declare no conflicts of interest.

http://dx.doi.org/10.1016/j.jpeds.2014.04.002

bodies in the alimentary tract (T18.x). In the province of Ontario, all hospital diagnoses and procedures are labeled and collected using ICD-10 codes for administrative purposes. We also reviewed the administrative database of consultations performed by the general surgery service to assure no cases were missed. All charts were reviewed by authors M.S. or D.R. to identify patients who met the inclusion criteria. This criteria included all patients under 18 years of age suspected of or confirmed to have a magnet ingestion via parental report, diagnostic imaging, or pathology report. Children presenting on multiple occasions with respect to the same ingestion event were abstracted as a single case. We did not include patients who were seen with a foreign body in the external eye, ear, respiratory tract, or genitourinary tract. We chose to limit our scope to the alimentary tract because the majority of complications reported with magnet ingestions arise from perforations and fistulae of the stomach, small bowel, and colon.[6]

We collected data on patient demographics; type of imaging obtained and findings; patient disposition; procedures or operations; length of hospital stay; and specialist consults. For all encounters where diagnostic imaging was available, 2 observers independently examined the films to assess for number, shape, and approximate size (using the linear measurement tool of our digital image viewing software [GE Centricity RA1000 Workstation v 3.2; GE, Little Chalfont, United Kingdom]) of the magnets. Magnet volume was calculated for foreign bodies where orthogonal views allowed both observers to confidently assess the shape and obtain necessary measurements to calculate the approximate volume.

To examine whether a difference in magnet-injury epidemiology might be attributable to the widespread introduction of small spherical magnet sets in 2009,[13,14] we compared the first 8 years (2002-2009, period 1) of the study period to the last 3 years (2010-2012, period 2). We used our institution's annually reported number of ED visits to create magnet-related injury rates. We used Poisson regression as well as 2-tailed *t* tests with unequal variance to compare incidence rates and magnet characteristics between these 2 time periods.

The study was approved by the hospital's Research Ethics Board.

Table I. Summary of patient demographics, care received, and magnet characteristics

Alimentary tract magnet ED presentations	94
Confirmed magnets (%)*	75 (80)
Ingestions	72
Anal insertions	3
Suspected magnet ingestion (%)†	19 (20)
Multiple magnets (% of confirmed ingestion)	30 (42)
Magnets with other metallic FB (% of confirmed ingestion)	2 (3)
Sex (% of confirmed ingestion)	
M	47 (65)
Female	25 (35)
Age in years, median	4.6
Minimum	1.1
Maximum	13.1
Developmental disabilities (% of confirmed ingestion)	4 (5)
Autism	3 (4)
Global developmental delay	1 (1)
Diagnostic tests (%)	
Imaging	72 (100)
Blood work	11 (15)
Procedures (% of confirmed ingestion)	
Esophagogastroduodenoscopy	7 (10)
Colonoscopy	1 (1)
Rigid sigmoidoscopy	1 (1)
Rigid esophagoscopy	1 (1)
Surgical removal	6 (8)
Shape of magnet assessed (% of confirmed ingestion)	66 (88)
Spherical	30 (46)
Cylindrical	28 (42)
Other	8 (12)

M, male.
*Either confirmed at time of removal or by a history of suspected or witnessed magnet ingestion and presence of radio-opaque FB on imaging.
†Presented with history of magnet ingestion but no workup was conducted or imaging failed to confirm presence of radio-opaque FB.

Results

Between April 1, 2002 and December 31, 2012, a total of 2722 patient visits were classified as injury because of alimentary tract foreign bodies. Upon reviewing these files, 94 unique children were identified as meeting our inclusion criteria. In 75, magnets were confirmed after removal or by a combination of history of magnet ingestion and at least one radio-opaque foreign body seen on medical imaging. The remaining 19 patients presented because of suspicion of ingestion, but either no magnets were found on imaging or no further workup was conducted. Demographic data are summarized in Table I.

The incidence rate ratio (IRR) of magnet-related injuries after the introduction of the desk toys was 2.94 (95% CI, 1.84-4.70). The IRR for magnet-related injuries with multiple magnets was 8.4 (95% CI, 3.44-20.56). The year-to-year IRR over the entire study period was 1.08 (95% CI, 0.61-1.55) for magnet-related injuries and 2.13 (95% CI, 1.23-3.02) for cases involving multiple magnets. Incidence over time is illustrated in the Figure.

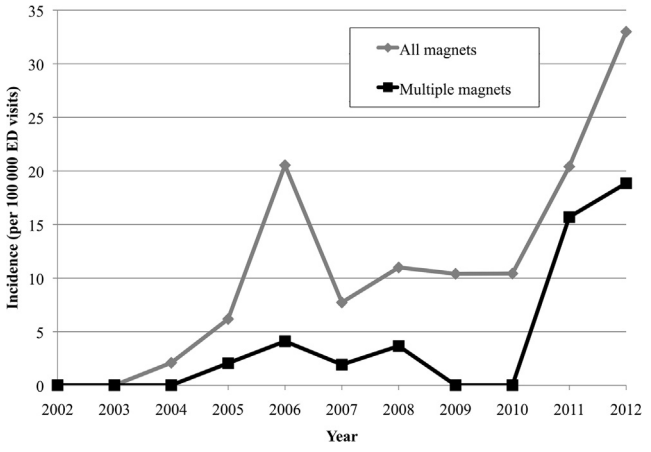

Figure. Incidence (per 100 000 ED visits) of alimentary tract magnet injuries over time.