

## Magnetic bead toy ingestion: uses and disuses in children

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Accepted: 23 January 2013 / Published online: 15 February 2013  
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**Abstract** A 2-year-old female presented acutely with peritonitis and small bowel obstruction. An abdominal radiograph demonstrated a radiopaque foreign body. At laparotomy she was found to have bowel perforations with entero-enteric fistulae caused by four magnets. The magnets were removed, and debridement and closure of the perforations performed. We review our case and highlight this problem to other medical practitioners as a potential cause of significant morbidity and mortality in the paediatric population.

### Introduction

We report a case of bowel injury after ingestion of more than one magnet and review the potential health hazards of magnet ingestion in the paediatric population. Early suspicion of this problem and immediate intervention is advised to reduce morbidity.

We review our case and highlight this problem to other medical practitioners as a cause of significant morbidity and potential mortality in the paediatric population.

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### Case report

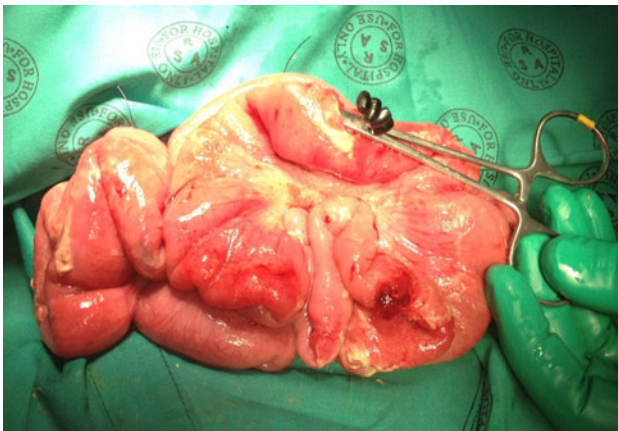
A previously fit 2-year 8-month-old girl was referred from a primary health care clinic with a 2-day history of vomiting after meals, abdominal pain and lethargy. There was no history of foreign body ingestion. On examination she looked unwell and was irritable. She was afebrile with a respiratory rate of 28 breaths per minute and saturation of 100 % in room air. Her heart rate was 108 beats per minute, and she was warm and well perfused with a capillary refill of 2 s. A nasogastric tube was passed, and she had bilious aspirates. Cardiovascular and respiratory examinations were within normal limits. Her abdomen was distended with mild but diffuse tenderness and right upper quadrant guarding. There were no audible bowel sounds. Initial investigations were performed: a full blood count (Haemoglobin 12.2 g/dL, MCV 76.8 fl, platelets  $652 \times 10^9/L$ , white cell count  $7.6 \times 10^9/L$ ) and urea and electrolytes (sodium 128 mmol/L, urea 3.9 mmol/L, creatinine 31  $\mu\text{mol/L}$ , potassium 4.3 mmol/L, chloride 96 mmol/L), demonstrating a thrombocytosis, and hyponatremia.

An abdominal radiograph prior to transfer to our institution showed an unusual looking foreign body overlying the 5th lumbar vertebrae. There were dilated bowel loops and a paucity of bowel gas distally. There was no evidence of pneumoperitoneum. Repeat radiographs at our institution the following day showed the foreign body in the same location and persistent small bowel dilatation with no free gas evident (Fig. 1). We suspected magnet ingestion with complications due to the stacked appearance on the radiograph and proceeded to operative intervention.

A diagnostic laparoscopy was performed initially. There was generalised peritonitis with free intra-peritoneal pus. The bowel was grossly dilated resulting in a limited



**Fig. 1** Abdominal radiograph at our institution



**Fig. 2** Intra-operative pictures: the bowel perforations are shown caused by fistulisation due to pressure necrosis from the magnets

working space, which required conversion to a laparotomy using a transverse right supra-umbilical incision. The magnets were found clumped together at the base of three loops of small bowel. There were two fistulae with three perforations at 70, 90 and 120 cm from the duodeno-jejunal flexure (Fig. 2). The distal small bowel was collapsed with a normal colon and appendix. Four magnets were retrieved and the edges of the fistulae debrided and sutured closed in a transverse fashion with 5/0 polydioxanone absorbable sutures. The magnets were all identical, oval in shape with a lumen in the middle of the magnet. They were strongly attracted to each other and to metal forceps as shown (Fig. 2). Postoperatively she made an uneventful recovery and was tolerating a full ward diet by day 4 post surgery and discharged home on the sixth postoperative day without further complications on a 6-week follow-up.

## Discussion

The first report of gastro-intestinal complications of multiple magnet ingestion was in 1995 by Honzumi [1]. He reported a case of a 3-year-old girl who presented with abdominal pain and bilious vomiting. She underwent an exploratory laparotomy and was found to have a jejuno-ileal fistula with multiple ingested magnets.

A single swallowed magnet should pass uneventfully through the gastrointestinal tract, dependant on size, as any other foreign body. However, multiple magnets or magnets ingested with other magnetic objects are associated with considerable morbidity. They can attract each other with forces up to 1,300 G [1] causing complications if intervening bowel is present. Complications can occur anywhere along the gastrointestinal tract. Most complications are due to pressure necrosis with fistulation across adjacent segments of small bowel wall caught between two magnets or a magnet and another metal body [2]. Other reported problems include ulceration [3], gastric outlet or bowel obstruction [4], oesophageal perforation [5–7], gastro-enteric fistulae [3, 8–10], small bowel volvulus [11–13] and appendicitis due to ileocaecal fistulation [14].

Presentation is frequently delayed, as patients are asymptomatic until complications have occurred, and even if a foreign body is detected on an abdominal radiograph, management may be conservative if the magnetic and multiple nature of the ingested objects are not recognized.

Magnet ingestion and the complications have been an emerging problem in the past 10 years with numerous magnet toy parts being implicated. In 2006, the Consumer Product Safety Commission in the USA recalled two toys due to this problem [15]. Magnetix sets were building sets for children over the age of 3 years. They were made up of plastic building pieces, steel ball bearings and neodymium magnets. Detachable magnetic parts were responsible for intestinal injuries in children including one death. A similar problem occurred with Polly pocket toys requiring a recall of certain Polly pocket products in the same year.

Since 2008 there has been a new type of magnet, marketed predominantly as a desk toy. They are identical, spherical or cube-shaped powerful magnets usually between 3 and 6 mm in diameter. The majority are made of neodymium–iron–boron (NIB) and are extremely strong magnets sold in batches. Other names for these magnet sets are “rare earth metals” and “magnet balls”. There have been an estimated 1,700 ingestions from such magnet sets treated in emergency departments in the USA between January 2009 and December 2011 [16].

This trend is mirrored in a recent review of the literature. There were 52 cases reviewed between 1995 and 2011 with over half of the cases, 54 %, ( $n = 28$ ) were reported between 2007 and 2011 [17]. There have also been a

number of reports in the media about complications after ingestion of these desk toys latterly. In Oregon, USA a 3-year-old girl required a laparotomy for 37 ingested balls causing fistulae, and a 12-year-old girl in Newcastle, Australia had similar injuries requiring laparotomy after swallowing four of these toys [16]. Both these cases were caused by ‘Bucky balls’, a desk toy made of small powerful magnetic balls which has a variety of uses: jewellery, attaching objects to the fridge, kneading for stress relief. The manufacturer states that these balls are not for use by children. They are labelled with a warning regarding problems with serious injury or death and the need for immediate medical attention if the balls are swallowed or inhaled. In July 2012, the Consumer Product Safety Commission in the USA filed a law suit against the manufacturer of these toys in an effort to prevent further sales [16]. They state that these toys pose a grave danger to children and took legal action after the company responsible for its distribution refused voluntary recall of the magnet toys.

In the United Kingdom concern regarding this problem has prompted two paediatric surgeons to write a letter to the *Lancet* highlighting the problem to other medical practitioners [18]. They had two recent cases; an 18-month-old child who had ingested ten magnets with subsequent fistulisation and an 8-year-old who presented with clinical findings suggestive of appendicitis and was found at laparotomy to have two long magnets fistulating through the caecum and small bowel.

A magnetic database (MagDB) exists to investigate the morbidity of magnets in children [19]. The data is collated from public surveillance databases and the scientific literature. The median age of children affected is 4 years with 25 % under 2 years of age. Overall, there are more males affected but an equal amount of males and females are affected in the under 3-year olds. The median number of ingested magnets is two. The majority of patients are asymptomatic. For the patients who had symptoms non bilious vomiting was common. Other symptoms recorded were abdominal pain, diarrhoea, fever and a non-specific “flu-like illness”. The non-specific symptoms possibly explain the delay in presentation of a median of 3 days. The median postoperative in-hospital stay was 7 days, which was significantly longer than for children admitted after complication of non-magnetic foreign bodies. They also highlighted that the affected children often have a complex clinical course.

Urgent removal is recommended in all cases of multiple magnet ingestion, unlike the expectant approach taken with the majority of foreign body ingestion cases.

Removal historically required an open laparotomy, although the use of laparoscopy is emerging as a primary modality or an adjunct to management. In our case,

laparoscopy was utilised but due to the degree of small bowel dilatation, conversion to a laparotomy was required.

## Conclusion

Small magnetic toy sets growing in popularity are easily ingested. This almost inevitably leads to severe consequences, as our case demonstrates.

We would like to highlight the dangers of magnet ingestion to all health professionals who look after children. Recognition of the problem and the stacking appearance of apposed magnets on the radiograph can enable earlier diagnosis and intervention before secondary complications such as bowel perforation and peritonitis occur.

**Acknowledgments** The authors acknowledge the Dowager Countess Eleanor Peel Trust for awarding the Peel Travelling Grant towards funding of the first author’s fellowship year.

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