MAGNETIC FOREIGN BODY INGESTION IN CHILDREN: IMPACT OF SURGICAL INTERVENTION TIMING. A CASE SERIES AND LITERATURE REVIEW

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Abstract
Background
Accidental ingestion of foreign bodies in young children and toddlers is common. Most will pass spontaneously without any harm. However, when foreign bodies are magnetized, significant problems can occur. Exceptionally strong magnetic pull and 2 magnets in separate parts of alimentary canal can quite easily attract, potentially causing damage to the intervening structures. We present our experience where earlier surgical intervention was required to extract magnets.

Material and Methods
A review of case notes of three patients referred to a tertiary Paediatric Surgery centre during the period March 2011 to August 2014. They have completed follow up period for 2 years at least before discharge them back to GPs care successfully. Retrospective review of similar published articles on PubMed and medline.

Conclusion
Authors recommend close observation, high index of suspicion and early surgical intervention. More public and medical awareness is needed of dangers posed by these readily available objects.

Keywords: magnetic FB, early surgical intervention, children.

Introduction
The accidental ingestion of foreign bodies (FB) in young children and toddlers is a common occurrence [1]. Most of these objects are small and will pass spontaneously without any harm to the gastrointestinal tract. However, when the foreign bodies are magnetized, significant problems can occur. Neodynium (earth) magnets especially, have an exceptionally strong magnetic pull and 2 magnets in separate parts of the alimentary canal can quite easily attract, potentially causing damage to the intervening structures [2]. Many of case series have previously highlighted the danger of these magnets and we present here a further 3 consecutive cases where surgical intervention was required to extract the objects.

Materials and Methods
A review of the case notes of three patients referred to a tertiary Paediatric Surgery centre during the period March 2011 to August 2014 (Table 1). They have completed follow up period for 2 years at least before discharge them back to GPs care successfully. Retrospective review of published articles on PubMed and medline.

Case histories
Case 1
A 30-month-old boy presented to the emergency department (ED) with a history of several magnetic FB having been swallowed 4 days previously. He had vomited once but otherwise had no symptoms, had been eating and drinking with normal bowel motions. The abdomi-
Table 1. Demographic summary of reported cases has ingested magnet FBs and their management.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (Months)</th>
<th>Sex</th>
<th>No. of ingested Magnet FBs.</th>
<th>Symptoms at presentations</th>
<th>Operative findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>M</td>
<td>4</td>
<td>None</td>
<td>Aligned magnets forming fistula between stomach, ileum, mesentery &amp; caecum</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>F</td>
<td>2</td>
<td>None</td>
<td>One in caecum &amp; one in stomach. Post-operative haematemesis</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>M</td>
<td>4</td>
<td>Abdominal pain &amp; vomiting</td>
<td>One in stomach and three in caecum. Small bowel erosions</td>
</tr>
</tbody>
</table>

Figure 1. A 30 month old boy presented to the emergency department (ED) with a history of a number of magnetic FB having been swallowed 4 days previously.

Figure 2. A 16-month-old girl presented with a 6 hour history of abdominal discomfort and non-bilious vomiting. The parents reported 2 small magnets having been swallowed. AXR was performed before the second operation.

Intraabdominal examination was entirely normal. The main reason for presentation was parental concern. They had been reviewed several times at their local hospital and had been told the objects would most likely pass spontaneously. A plain abdominal radiograph demonstrated 4 small spherical FB arranged in a linear pattern in the upper abdomen. The X-ray appearances were identical to the image from 48 hours previously at the local hospital (Fig. 1). After a short period of observation and repeat imaging that showed no progression of the objects, he was taken for surgery. An initial endoscopic examination revealed one of the FB embedded in the wall of the greater curve of the stomach. No further FB was seen on endoscopy so it was decided to proceed to laparotomy. The intraabdominal findings revealed an internal fistula caused by the aligned magnets connecting stomach, mid-ileal loop, colonic mesentery and mid transverse colon. There was no free gas or fluid / faeces within the peritoneal cavity. The area of small bowel adjacent to the magnet erosion site was not viable and therefore a limited resection and anastomosis was performed. The perforations in the stomach, mesentery and colon were directly repaired. An incidental appendicectomy was also performed. All 4 FB were retrieved. The post-operative recovery was uneventful.

Case 2
A 16-month-old girl presented with a 6-hour history of abdominal discomfort and non-bilious vomiting. The parents reported 2 small magnetized FBs having been swallowed while
Figure 3. A 30-month-old boy, presented to the emergency department with central abdominal pain and non-bilious vomiting for 1 day. The parents gave a history of small magnetics having been swallowed at home 48 hours previously.

she was playing. She was systemically well and afebrile but with mild abdominal tenderness in the right iliac fossa. Plain abdominal radiograph has shown 2 linear closely apposed FB on the right side of the abdominal cavity (Fig. 2). A repeat X-ray showed no progression of the objects therefore a laparotomy has been performed. One magnet was lodged in the appendix and was removed through the stump. The 2nd magnet was however not located. Mobile imaging in theatre showed it to be in the RUQ and it was therefore left to pass spontaneously. Unfortunately, on the second postoperative day she developed severe haematemesis. After resuscitation, she was taken back to theatre for an endoscopy which failed to locate the bleeding point and therefore she had a further laparotomy. A gastric perforation located at the greater curvature was identified and was over-sewn. The originally missed 2nd FB was identified in the stomach and milked down to the large bowel to pass spontaneously. The patient was relatively slow to recover and following discharge, five months later re-presented with symptoms of bowel obstruction which was managed conservatively.

Case 3
A 30-month-old boy, presented to the emergency department with central abdominal pain and non-bilious vomiting for 1 day. The parents gave a history of 4 magnetic small FB having been swallowed at home 48 hours previously. His general observations were normal however there was mild tenderness in the right abdomen. A plain abdominal radiograph has demonstrated many of cylindrical metallic FB aligned vertically just to the right of the midline (Fig. 3). After 36 hours, repeat X-ray showed only a slight change in the orientation of the objects but no obvious progression. The abdomen throughout this time was soft and non-tender. The patient was taken to theatre for a laparotomy. The findings were: 3 magnets aligned together in the caecum. These were milked into the appendix and removed. A small area of terminal ileum was eroded and repaired directly. The remaining magnet was in the stomach and retrieved via gastrotomy. There were no postoperative complications.

Discussion
Foreign body (FBs) ingestion is relatively common in the Paediatric age group especially between the ages of 6 months and 3 years [3]. FB can be harmful and cause significant morbidity and mortality. Multiple magnetic FBs and metals attract each other and establish pressure necrosis and ischemia of the bowel wall. Subsequent ulceration of the adherent wall can occur with perforation and fistula formation. Other major complications as reported by Centre of Disease Control (CDC) are volvulus, ischemia, sepsis and (rarely) death [4]. An increased number of swallowed magnetic FB, means an increased risk of bowel complications. The largest number of ingested magnetic FBs reported worldwide is 100 [5]. Unless there is proper history and witness of ingestion of magnetic FBs, it is difficult to diagnose [3]. The time of ingestion and, type and number of FBs are important to disclose since these critical co-factors will direct the management plan. Autism is a contributing factor in 10% of cases along with impaired mental development. Both can delay presentation to several weeks [5]. Clinical symptoms are usually nonspecific and misleading. Centrally located abdominal pain is commonly reported by parents and younger children. Physical examination of abdomen is usually noninformative. However, the finding of abdominal signs should raise the surgeon’s level of suspicion that the FB have caused an intra-abdominal injury [5]. Plain abdominal X-ray (AXR) films are constantly requested as basic radiological investigation. Furthermore, the absence of FB movement, signs of bowel obstruction, multiple air/fluid levels, perforation and free air under diaphragm are uncommon findings. Magnification of images using PACS...
magnification tool is recommended and can assist in identifying the number and shape of magnetic FBs [6]. In a few reported cases, abdominal CT scans and US scans were used as first imaging modality or because of uncertainty of diagnosis [5]. There is of course no role for MRI.

Hayley et al. reported MRI induced multiple intestinal perforations with unknown metallic or magnetic FB ingestion [7]. Traditional algorithms used in management of ingested FBs have advocated spontaneous passage of ingested FB through the gastro intestinal tract [8]. Surgical intervention is rarely required in less than 1% of objects which failed to pass [9]. The ingestion of multiple magnetic FBs should be considered a surgical emergency however. Any delay in recognition of the potential risks can lead to significant bowel damage. The patient will need admission and close observation. If the FBs are known or suspected to be magnetic, the best course of action would be retrieval via endoscopy. Surgical exploration should be initiated as soon as the first signs of obstruction or failure of progression of the magnet luminal journey [9]. Ferromagnetic detectors can be used if the history in unclear [7].

There are two important messages that should be taken from this; firstly, to the physicians and GPs to erase the belief that all FB will pass without harm [10]. Secondly to the industrial community to ban the marketing of toys containing magnets to children as young as 3 years old [9]. We can conclude that, FB ingestion is relatively common in the Paediatric age group. Since multiple magnetic FB may attract each other with considerable force and establish pressure necrosis of the bowel wall, ulceration, perforation and fistula formation. Hence, the harm can happen as a logic sequence.

Currently, several algorithms have been suggested for the management of these cases; however, these are not widely appreciated or followed. We recommend close observation, a high index of suspicion and early surgical intervention. More public and medical awareness is needed of the dangers posed by these readily available objects.

Acknowledgement
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REFERENCES

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