



# Incidental Ingestion of Rare-Earth Magnet Toys: A Disappearing Complication

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## Abstract

**Purpose:** Newly released toys made of small but powerful magnets, made of Rare-Earth Magnets (REM), could easily be obtained in South Africa. This is done through online internet shops as well as a number of retail shops. There is a small-print warning about ingestion hazards. However, in practice, accidental ingestion of multiple magnets can result in significant gut injuries.

**Material:** Over a 6 years period (July 2009- August 2015), 8 children with REM ingestions were seen. Seven requiring operative intervention.

**Result:** Laparotomy in all cases required disconnection and over-sewing of intra-luminal intestinal fistulae/perforations. No morbidity or mortality was noted in this cohort. One patient who ingested a single magnet was treated non-operatively.

**Conclusion:** Ingestion of more than one REM-made toy is dangerous and there is increasing regulation to ban these new magnetic toys.

**Keywords:** Magnets; Intestinal fistula; Rare-Earth Alloys; Bowel obstruction; Laparoscopy

## Introduction

Foreign body (FB) ingestion is undoubtedly common in children and in a recent survey, more than 125,000 ingestion of FB in children were reported to American Poison Centre. Most ingested foreign objects readily pass through the GIT and FB ingestion is not commonly considered on the differential diagnosis of acute abdominal pain.

In a recent cross-sectional survey of parents of more than 1500 children, 4% of the children had swallowed a coin. Almost no material causes complications once they have pass the oesophagus, the exception is wooden tooth picks [1].

In the past 20 years a new FB has been found as an ingested, Rare-Earth Magnets (REM) is recently discovered alloys. They are magnetized and have a powerful magnetic field many times stronger, unlike older iron based magnets. The most widely available type is Neodymium-Iron-Boron alloy which is commercially manufactured and used mostly in electronics industry.

They also became commonly available in the open market due to its low cost and marketed as puzzle-like toys in 1990's.

Because many look similar to silver or color cake ball decoration, they are mistakenly ingested by young children. Accidental ingestion of REMs is reported to be hazardous in a large international review, which did not include Africa [2]. This is the first large cases report which high lights implication of REMs ingestion in Africa.

## Materials and Methods

In a retrospective review over a 6-year period (July 2009- August 2015), eight children with ingestion of toy REMs were treated by the author in Johannesburg, South Africa. There were 7 males and 1 female. Seven required operative intervention due to signs and symptoms of peritonitis. Age range of patients was from 2 to 11 years.

Three parents obtained the magnets from car dealerships as gifts and the remaining 5 bought them from online toy-companies, music stores and curiosity shops.

Five children were seen by doctors in emergency rooms and they were treated conservatively as any other benign foreign body in the gastro-intestinal tract. Repeat X-rays a week later confirmed

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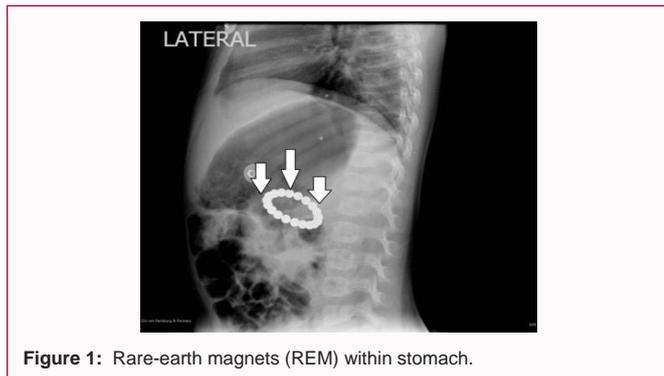


Figure 1: Rare-earth magnets (REM) within stomach.

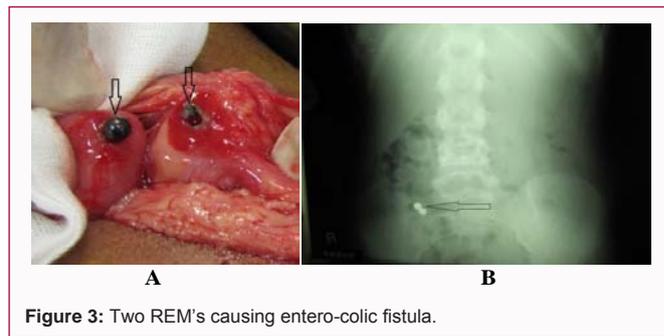


Figure 3: Two REM's causing entero-colic fistula.

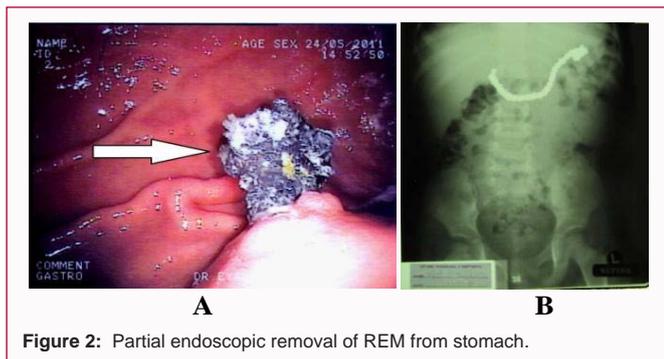


Figure 2: Partial endoscopic removal of REM from stomach.



Figure 4: Ingested REM in straight line.

non-passage and referral to pediatric surgeons.

Because of this delay surgical intervention was delayed 4 -12 days post-ingestion of REMs.

Written parental consents were obtained for ethics requirement.

## Results and Discussion

In all but one patient worsening abdominal pain and clinical signs of peritonism necessitated surgical intervention. Symptoms appear to occur within 3-4 days after ingestion in 4 patients who could verbalize adequately; they confirmed that they ingested REMs one at a time over period of minutes to hours apart.

In 2 cases, abdominal X-ray was suggestive of REMs within the stomach (Figure 1). These patients underwent endoscopic attempt at extraction but it was only partially successful by removing a few magnets (Figure 2a,2b). In one other, patient laparoscopic evaluation confirmed the presence of an entero-colic fistula but repair and extraction of the magnets deemed too complicated and the procedure was converted to open laparotomy.

Irrespective of the REM configuration on X-ray, significant gut injuries were caused.

Ingested REMs produced “pinching-type” injuries, in all 7 cases, resulting in intra-luminal intestinal fistulae with minor collection of pus around them (Figure 3a,3b). This was entero-enteric in 4 cases, gastro-duodenal in 2 and entero-colic in 1 case.

In one patient; ingestion of 2 REMs was enough to cause an entero-colic fistula. In the remainder cases, 4 to 20 magnets were ingested. These either remained more or less in a straight line (5 cases) (Figure 4, and 1) or produced a ring (2 cases).

In one case, a single magnet was incidentally noted in the sigmoid colon during follow-up angiography in a patient with a cardiac lesion. This ingested magnet passed the next day per rectum facilitated by

usage of rectal enema.

There were no peri-operative or post-operative complications in operative cases. Patients were discharged home day 5-8 post operatively. No surgical complications were noted at 6-week follow-up.

## Conclusion

REMs are strong permanent magnets made from alloys of rare earth elements. They are the strongest type of permanent magnets made, producing significantly stronger magnetic fields than other types such as ferrite or alnico magnets. The magnetic field produced by rare-earth magnets can be in excess of 1.5 teslas, whereas ferrite or ceramic magnets typically exhibit fields of 0.2 to 0.5 tesla [3].

There are hundreds of types of REMs manufactured in the past 4 decades; the first was described in 1966 by an American scientist, Dr. K. Strnat of the U.S. Air Force as an alloy of Samarium-Cobalt (SmCo5) compound, but it was not immediately used in industry due to its high manufacturing cost.

In 1983, a new REM was described when General Motors, Sumitomo Special Metals and the Chinese Academy of Sciences, independently, developed a high energy product from Neodymium-Iron-Boron (Nd2Fe14B) compound.

This new alloy is extensively used in many electrical and electronic devices such as hard drives and cordless tools. After the lapse of patent in 2002, many non-industrial usages of REM commenced. Its usage in children’s toys became a common commercial success since (e.g. Buckyballs®, Maxfield & Oberton Holdings LLC, New York, N.Y). At about the same time, the first report of bowel injuries surfaced [3] and first fatality in 2005 was recorded [4]. Since then there has been a total of 12 anecdotal reports in the medical literature [5,6] and many more in various lay-press news outlets.

Symptoms in our patients appear to occur within a few days after ingestion of REMs which is similar to reports from at least one other center [7].

The mechanism of injury is assumed to be pressure necrosis due to pinching of bowel by ingestion of these powerful magnets [4], which is swallowed by a child at different times. In two cases with ring effect, REMs were probably ingested minutes apart, causing pressure necrosis in stomach/duodenal area rather than in small bowel when ingestion was hours apart.

Ingestion of a single magnet and possibly a group of magnets attached together does not cause injury, as was noted in one of our cases.

In a number of developed countries, REMs toy manufacturers and suppliers of these magnets are either banned completely or required to place extensive and large print warnings about this danger on their website and on the packages.

Likewise, South African Consumer Protection Act has strict measures with regard to false advertising but only for print media [5]. However, due to relatively lax online advertising laws in South Africa, these warnings are rarely adhered to. There are at least 2 online companies and 1 retail music store which sell REMs with minimal warning about dangers to children. The packaging suggests in small-print that “in case of ingestion, medical attention must be sought”. This warning is woefully insufficient and does not signify potentially fatal consequence of REMs ingestion to the parents. This is relative to more stringent warning label recommended in more developed countries [6].

This report confirms that REMs ingestion is not easily recognized by many doctors due to its novelty and rarity but ingestion of even 2 REMs can result in intra-luminal fistula. Rapid ingestion of high number of REMs causes gastro-duodenal injury and/or fistula due to ring effect.

Endoscopic or laparoscopic removal appears to be futile; once a ring is formed in upper gastro-intestinal (GI) tract or if it has passed through the duodenum because of the complexity of the fistulae formed.

This is a different outcome to those made by other authors, where an early recognition and immediate attempt at upper GI endoscopic removal of REMs was possible in a minority of cases [2,8].

REM toys are dangerous and even fatal if ingested. By definition, toys are ultimately designed for children’s use and virtually no adults will play with magnetic toys. Therefore, it is recommended that these dangerous toys are banned irrespective of warning labels. Social and published media have had positive impact and most companies no longer advertise or sell these products.

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