


ORIGINAL ARTICLE

Water beads: Expanding toy and ‘new’ problem for paediatric surgeons and community

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Background and Study Aims: Water beads made from superabsorbent polymers can lead to bowel obstruction, which can sometimes be fatal. This article aims to highlight the dangers of such toys and to propose an innovative, safe and effective approach to diagnostic and therapeutic management.

Patients and Methods: We report two cases of children with intestinal obstruction following the ingestion of products based on superabsorbent polymers. They were diagnosed and treated in two different centres using varying techniques.

Results: We compare our experiences with the few cases reported in the literature. Since water beads are radiolucent, ultrasound or CT scans are crucial for diagnosis. As in one of our cases, radiography of the upper gastrointestinal tract with contrast can be very helpful. Laparotomy with enterotomy is the main surgical approach reported in literature to extract the water spheres. We report two cases managed using a minimally invasive approach, and one of them is the second one described in the literature, treated endoscopically.

Conclusions: Water beads pose a potential danger to children, making it necessary to limit the sale of this type of toy. We offer a management flowchart based on our experience and evidence from the literature.

Key words: endoscopy; laparoscopy; paediatric surgery case reports; superabsorbent polymers; water beads case reports.

What is already known on this topic

- 1- Water beads made from superabsorbent polymers can cause bowel obstruction if ingested by children.
- 2- Minimally invasive treatments are possible. To date, only one case of endoscopic treatment for duodenal obstruction has been reported.
- 3- Despite the demonstrated dangers, the sale of these objects as toys remains permitted.

What this paper adds

- 1- Based on our experience, and in comparison with existing literature, we propose an initial flowchart that could serve as a useful guide in cases of water bead ingestion.
- 2- The choice of minimally invasive treatment should depend on the site of the obstruction. A foreign body lodged in the duodenum can be effectively and safely treated via an endoscopic approach. If the obstruction is located distal to the first jejunal loop, laparoscopic-assisted enterotomy for foreign body removal is recommended.
- 3- We emphasize the urgent need to restrict the sale of these hazardous items as children's toys.

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Water beads made from superabsorbent polymers were initially developed for agricultural use due to their ability to absorb and retain water. To date, they are sold as children's toys or therapies for autism spectrum disorders but they can be dangerous. When placed in water, these small balls can expand in size by 150 to 1500 times. So, if swallowed, they can be responsible for bowel obstruction, sometimes fatal.

We describe our experience of two cases of children with intestinal obstruction following ingestion of these toys. The aim of this report is to raise awareness about these dangerous objects and, more importantly, to analyse potential diagnostic and therapeutic

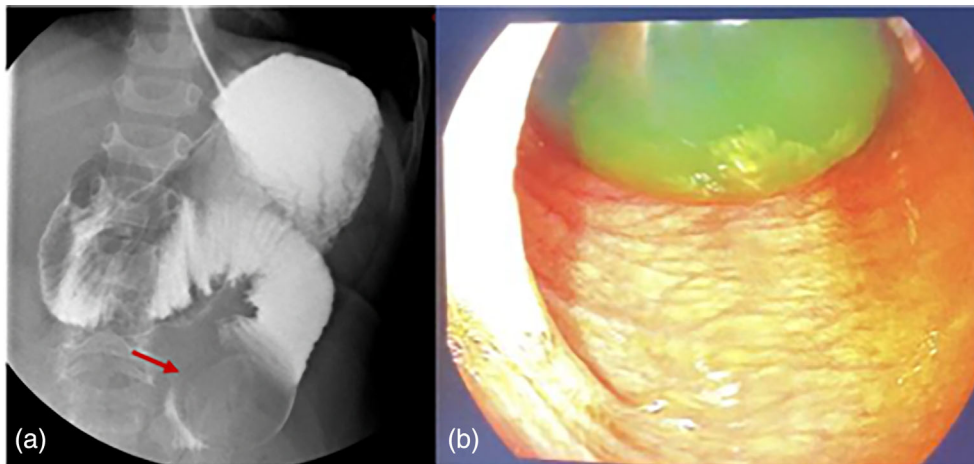


Fig. 1 (a) Contrast upper gastrointestinal radiography: a radiopaque spherical image with a diameter of 3–4 cm in correspondence with the first jejunal loop (arrow), about 3 cm from the Treitz. (b) Endoscopy view: a large water bead obstructing the third portion of the duodenum.

techniques by comparing our experiences with those documented in the literature.

Methods

Case report 1

An 11-month-old girl with bowel obstruction was transferred from a suburban hospital due to persistent biliary vomiting and ‘food aversion’ for 4 days. Her mother had the suspicion of water bead’s ingestion 6 days before. The remote anamnesis and clinical examination of the abdomen revealed no pathological findings. The initial ultrasound was negative, and an abdominal X-ray showed no foreign bodies. On the fourth day, a nasogastric tube was placed and 250 cc of bile was found. Contrast upper gastrointestinal radiography was done and showed in correspondence of the first jejunal loop, about 3 cm from the Treitz, a radiopaque spherical image with a diameter of 3–4 cm (shown in Fig. 1). After multidisciplinary discussion, she was transferred to our clinic and we performed an endoscopy with the removal of the ball sited in duodenum after crushing it (shown in Fig. 1). Two days after, the patient evacuated eight additional smaller water beads by serial enemas and oral treatment with an isosmotic macrogol solution. The postoperative course and follow up were regular.

Case report 2

An 11-month-old patient who arrived in the emergency room with multiple vomiting and constipation. Her mother reported suspected ingestion of water beads 2 days earlier. Nothing was reported in the remote history and the patient presented moderate distension and meteorism on clinical examination of the abdomen. Abdominal X-ray showed evidence of air fluid levels in the umbilical region and left flank. Ultrasound revealed distension of the jejunoileal loops up to 25 mm containing multiple round anechoic formations (shown in Fig. 2). In the suspicion of intestinal obstruction due to the ingestion of superabsorbent

spheres, the patient underwent urgent laparoscopy. After visualization of ileal loops dilated by multiple intraluminal structures, we made an enlargement of the umbilical laparotomic incision using a self-retractor. After that, the intraluminal foreign bodies were pushed up to the most distal sphere, which was larger probably because it was ingested first (shown in Fig. 2). At this level, enterotomy was made and the five intact spheres were removed. At the end enterorrhaphy was performed. The postoperative course and follow up were unremarkable.

Results: Literature Review and Discussion

Small colourful spherical objects that are very attractive to children can be mistaken for candy and swallowed. These objects, known as water beads, are made from superabsorbent polymers. This product is popular in horticulture thanks to its ability to grow up when immersed in water, retain up to 100 times their weight and gradually release the liquid. These water beads are also marketed as toys and used in teaching and sensory therapy for children with autism spectrum disorders and sensory processing disorders.

In 2012, the first three cases of ingestion of these water beads were reported in the literature. Moon *et al.*¹ and Zamora *et al.*² described cases of an 18-month-old and 8-month-old children with intestinal obstruction due to ingested superabsorbent polymer balls. These cases were successfully treated by laparoscopic-assisted enterotomy. The third case involves a 6-month-old male infant who had a delayed diagnosis of 25 days. He underwent the same surgical procedure but developed a postoperative complication of enterorrhaphy leakage and septicemia which led to his death.³

Various types of water balls have been taken off the market⁴ but many similar products remain readily available for purchase. In fact, there have been other reported cases in the literature of intestinal obstruction caused by these products. One such case involved an 18-month-old female in India, reported in 2014 by

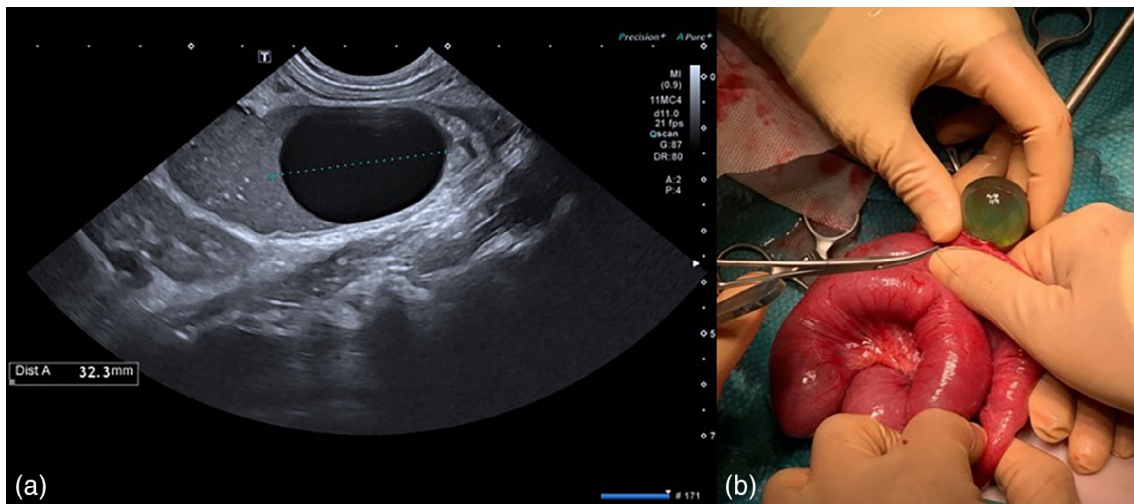


Fig. 2 (a) Ultrasonography: jejunoileal loops show distension up to 25 mm containing round anechoic ball formation. (b) After enterotomy, the intraluminal foreign bodies were pushed to the most distal sphere.

Muthukumar *et al.*,⁵ who required resection of the intestinal tract containing the foreign body.

An asymptomatic 2-year-old girl who ingested approximately 100 water beads was successfully managed with whole bowel irrigation even if during the treatment she developed the adverse effect of hypoglycemia.⁴

Singh *et al.*⁶ described a case of a 9-month-old with partial duodenal obstruction for a month. The water bead was mistaken for a cystic duplication of the duodenum. They found the foreign body at laparotomy exploration and broke it intraluminally to remove rectally in piecemeal.

Another case misdiagnosed as intestinal duplication is one of the two cases described by Faizah *et al.*⁷ who reported two cases involving patients aged 18 and 17 months with intestinal obstruction. Ultrasound scans revealed well-defined anechoic thin-walled lesions, and both of them underwent urgent laparoscopic enterotomy.

In France, in 2017, another case required laparotomy surgical removal of an expanding bead which caused complete bowel obstruction in a 14-month-old patient.⁸

In the same year, the second case of anastomotic leakage after the same treatment is reported by Lip *et al.*⁹ The patient was a

Table 1 Characteristics of the only 12 cases of water bead ingestion reported in the literature to date

Article	Age	Sex	Clinic	Diagnosis	Treatment	Complication
Moon, 2012 ¹	18 m	F	Bowel obstruction	RX, US	LA enterotomy	No
Zamora, 2012 ²	8 m	F	Bowel obstruction	RX	LA enterotomy	No
Mirza, 2012 ³	6 m	M	Bowel obstruction	Upper GI RX, CT	Open enterotomy	Leakage, sepsis > death
Jackson, 2015 ⁴	24 m	F	Asymptomatic	RX	Whole bowel irrigation	Hypoglycemia
Muthukumar, 2014 ⁵	18 m	F	Bowel obstruction	US, RX	Open bowel resection	No
Singh, 2016 ⁶	9 m	F	Intermittent vomiting	Upper GI RX, US (duplication suspected)	Open exploration: broken FB intraluminally, rectally removed	No
Faizah, 2016 ⁷	18 m	F	Bowel obstruction	US, Lower GI RX (duplication suspected)	Open enterotomy	No
Faizah, 2016 ⁷	17 m	F	Bowel obstruction	RX, US	Open enterotomy	No
Fuger, 2017 ⁸	14 m	F	Bowel obstruction	RX, US	Open enterotomy	No
Lip, 2017 ⁹	22 m	F	Bowel obstruction	RX	Open enterotomy	Leakage > ileostomy
Lee, 2019 ¹⁰	12 m	F	Bilious vomiting	RX, brain MRI, CT	LA enterotomy	REDO for residual FB
Awolaran, 2024 ¹¹	-	M	Bilious vomiting and abdominal distension	RX, US	Open enterotomy	Occlusion for residual bead > relaparotomy + Endoscopy
Kim, 2020 ¹²	12 m	F	Bilious vomiting	RX, POCUS	Endoscopic remove	No

FB, foreign body; LA, laparoscopy assisted; POCUS, point-of-care ultrasound.

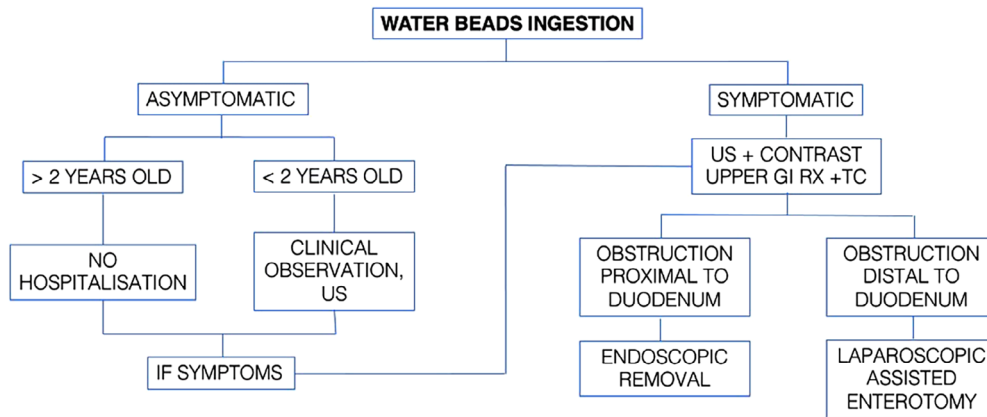


Fig. 3 Flowchart for the management of water bead ingestion.

22-month-old girl who required a temporary ileostomy due to this complication.

Two reinterventions for the presence of residual foreign body have been described in the literature. Lee *et al.* reported a case of a 12-month-old girl who required a redo of laparoscopic-assisted enterotomy due to residual foreign body.¹⁰ Awolaran *et al.*¹¹ described the recent case of a child who required a relaparotomy combined with upper gastrointestinal endoscopy for postoperative residual ball occlusion. They found a large obstructing bead at the duodenojejunal flexure.

The first case of endoscopic treatment with a retrieval net is described in 2020, and presents detection of duodenal obstruction with point-of-care ultrasound (POCUS).¹²

We also approached child by endoscopy with a good result and without complications.

To summarise, only 13 cases have been reported in the literature, 11 of which are patients under 2 years of age who presented with intestinal obstruction caused by the ingestion of water beads (shown in Table 1).

Ultrasound and X-ray remain first-line examinations, sometimes accompanied by gastrointestinal contrast study or CT scan. The foreign body was visualised by ultrasound in four cases, although two of these were mistakenly identified as intestinal duplication. In our centres, we used X-ray and contrast to diagnose the condition successfully. Based on our experience, we believe that when there is a suspicion of a proximal bowel occlusion, a gastrointestinal contrast X-ray can be very helpful in making diagnosis and may eliminate the need for a CT scan. In our opinion, a CT scan is not necessary as it does not provide essential information.

Thirty percent of the cases reported in the literature presented complications. These complications included two re-interventions due to the presence of residual foreign bodies,^{10,11} two dehiscences of the enterorrhaphy,^{3,9} one of which resulted in sepsis and death³ and the other in temporary ileostomy.⁹ We did not observe intra or postoperative complications.

Mehmetoglu¹³ made in 2018 a retrospective 10 years analysis of 21 patients who were observed for spontaneous defecation after water beads ingestion. All patients were asymptomatic and older than 2 years, none of them needed surgical intervention.

The ingestion of this type of foreign body is very rare, and the cases reported in the literature are few. Therefore, there is insufficient data to outline a precise diagnostic and therapeutic management approach. This type of patient generally requires an individualised diagnostic and therapeutic approach. However, considering our experience, compared to what has been described in the literature to date, we propose an initial flowchart that could serve as a useful guide in cases of water bead ingestion (shown in Fig. 3). We suggest a wait-and-see approach for asymptomatic patients older than 2 years of age, without the need for hospitalisation, while monitoring spontaneous defecation. Children younger than 2 years should be hospitalised and followed by point-of-care ultrasound. If symptoms suggestive of intestinal obstruction appear, contrast upper gastrointestinal radiography and possibly a CT scan may be useful to detecting the foreign body.

Depending on the site of the obstruction, it is possible to proceed with the most appropriate treatment. A foreign body stuck in the duodenum can be effectively and safely treated using an endoscopic approach.

On the other hand, if the obstruction is located distal to the first jejunal loop, removal of the foreign body by laparoscopic-assisted enterotomy is recommended.

In cases where endoscopic treatment is performed, it is necessary to continue careful clinical observation of the patient due to the inability to check the distal bowel.

Conclusions

Few cases of ingestion of water balls made from superabsorbent polymers have been reported in the literature. In this report, we present the first two cases described in Italy and propose a flow chart for managing these potentially dangerous items in the event of ingestion.

There is an urgent need to raise awareness about the dangers associated with these products. Furthermore, it is imperative to withdraw them from the market because they should not be sold as toys. We believe that items made of superabsorbent polymers should carry a warning indicating that they are dangerous for children under the age of two.

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