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Review Article

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Management of Gastrointestinal Foreign Bodies with Brief Review of the Guidelines

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ABSTRACT

Foreign body (FB) ingestion is a common health problem that affects children more than adults. According to gastroenterologists' guidelines, the management of FB ingestion differs slightly between adult and children. This review aimed to compile adult and children guidelines and establish an understandable association to reveal the requirements and timing of the endoscopic procedure, which is the most effective and least complicated technique for gastrointestinal FBs. Coins, pins, and chicken and fish bones have been the most commonly ingested FBs. However, with their increasing use in recent years, large batteries with lithium-ion conversion, stronger magnets composed of rare earth metals, such as neodymium, and superabsorbent objects have become the most morbid and mortal, necessitating new management strategies. Although the approach to gastrointestinal FBs is controversial, with different treatment options available in different disciplines, many studies have demonstrated the efficacy and safety of endoscopic procedures. Many factors influence the timing of endoscopy, including the nature, size, and location of the ingested object and the patient's clinical condition.

Keywords: Battery; Blunt; Button; Coin; Cylindrical; Magnet, Food impaction; Pointed; Sharp; Superabsorbent

INTRODUCTION

The treatment of gastrointestinal (GI) foreign bodies (FBs) is controversial, with different options available for *surgical and nonsurgical specialties.* Furthermore, gastroenterologists' guidelines for adult and pediatric age groups differ in their approach to FB ingestion and adult gastroenterologists must perform endoscopy on children in centers without pediatric gastroenterologists. This review aimed to compile guidelines for adult and pediatric age groups and establish a clear association. Furthermore, it was intended to examine less discussed issues, such as superabsorbent objects, and to draw attention to some studies that raised concerns about the guidelines. A PubMed/MEDLINE search was conducted using the terms "foreign body AND gastrointestinal and children OR adult" and "foreign body AND gastrointestinal AND guideline AND children OR adult". The subject of "Endoscopic removal for GI FBs" was reviewed, including the current literature. In particular, the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN)

[1], the European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) [2], the European Society of Gastrointestinal Endoscopy (ESGE) [3], the American Society for Gastrointestinal Endoscopy (ASGE) [4], the Italian Society of Pediatric Gastroenterology Hepatology and Nutrition (SIGENP), and the Italian Association of Hospital Gastroenterologists and Endoscopists (AIGO) guidelines [5] in either children or adults are line with the following plan:

1. Frequency of FB ingestion
2. Diagnosis of FB ingestion
3. Preparing for endoscopic removal
4. Button and cylindrical batteries ingestion
5. Magnet ingestion
6. Pointed or sharp object ingestion
7. Esophageal food impaction
8. Coin and blunt object ingestion
9. Superabsorbent object ingestion

FREQUENCY OF FB INGESTION

FB ingestion is a common health problem worldwide, and is more common in children than in adults. It is commonly accidental in children; however, in adults, it is caused by suicide, psychiatric illness, mental retardation, and secondary gain [6]. Incidents of child abuse are uncommon, and men and children under five years are most likely to ingest FB [7-10]. The American Association of Poison Control Centers recorded 94,051 FB ingestion in 2019 among all age groups (67,186 in children under 5 years and 12,223 in adults above 20 years). Three of the under 5 years patients who ingested batteries died [11].

While 80–90% of GI FBs are spontaneously egested, 10-20% require endoscopic removal, and less than 1% require surgery to remove the FB or treat associated complications [3,4]. Endoscopic FB removal has been reported to have a success rate of 88.5–100% [8,12-14].

DIAGNOSIS OF FB INGESTION

Patients who ingest an FB may develop dysphagia, odynophagia, retrosternal pain, stridor, FB sensation, hypersalivation, irritability, chest or abdominal pain, refusal to eat, wheezing, and dyspnea [1,3]. First, a detailed anamnesis covering the nature, number, time, and cause of FB ingestion and symptoms should be undertaken, followed by a physical examination. In a clinical setting, the ABC rules of resuscitation are valid. Aspiration occurs if a patient's secretions become excessive and cannot be swallowed, The evaluation and the choice to perform endoscopy should be completed as soon as possible.

Even if the patient is asymptomatic, all patients with suspected FB ingestion should be admitted to the emergency department and have a radiographical examination. If necessary, bidirectional neck, chest, abdomen, and pelvis radiographs should be taken. For radiolucent foreign entities, computed tomography (CT) may be performed. Magnetic resonance imaging (MRI) is ineffective for detecting FBs. There are no data on the use of ultrasonography and metal detectors. Radiographs should be used to evaluate mediastinal and peritoneal free air and the presence and number of FBs. However, plain radiography may fail to demonstrate subdiaphragmatic free air. In cases of doubt, it should be evaluated using CT. Before battery removal, MRI scans should never be performed [1,3,15]. Positive predictive values for radiographs are 100% for metallic objects, 43% for glass objects, 26% for fish bones, and 0%

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for splinters and woody objects [1]. The false-negative rate for food bolus impaction is 87% [3]. Point-of-care ultrasound (POCUS) is effective in identifying and monitoring ingested FBs in children [16]. POCUS use in children will increase in the future, as it is in adults [17,18].

PREPARING FOR ENDOSCOPIC REMOVAL

The timing of the endoscopic procedure is determined by many factors, including the nature and size of the FB, its location in the GI tract, the patient's clinical condition, the time elapsed after possible ingestion, the patient's nil per os (NPO) status, family's anxiety, and the endoscopist experience [1,5].

The timing of the endoscopic procedure can be defined as follows [1]:

- Emergent: Within 2 hours of arrival, regardless of the NPO rules
- Urgent: Within 24 hours of arrival, following the required NPO rules

ESGE/ESPGHAN recommends endoscopic removal in children under general anesthesia or, if general anesthesia is not possible, with deep sedation [2]. SIGENP/AIGO recommends that an emergency endoscopy must be performed under general anesthesia with airways protection [5]. For children with complete airway protection, general anesthesia with endotracheal intubation is recommended, which is ideal for most emergency procedures [1,3,5]. Alternatively, endotracheal intubation has been recommended in selected cases such as cases with a high risk of aspiration (i.e., full stomach, proximal esophageal location of the FB, food bolus impaction), objects that are difficult to remove, and multiple objects [3,4].

For FBs at or above the level of the cricopharyngeus muscle, otorhinolaryngology (ENT) consultation is advised [4]. Pediatric, ENT, or cardiothoracic surgeons use a rigid endoscope to remove FBs in some regions and countries in the upper esophagus [9,10,19-22]. In some institutes, these procedures are routine processes in all cases. The rigid endoscope is may be only safe for proximal esophageal objects [2]. Upper esophageal FBs can be easily removed with Magill forceps or balloon (e.g., Foley catheter) extraction using fluoroscopy rather than endoscopy. These methods were followed successfully by several institutions [19,22-24].

Before performing an endoscopic treatment on an unfamiliar FB, a sample of objects of similar size and thickness should be rehearsed outside the patient using appropriate forceps. Radiographs should be performed again to rule out the possibility of FB displacement, before beginning the endoscopic removal procedure. Almost all FBs can be extracted with rat-toothed forceps and a net. Therefore, both types of forceps should be provided in the endoscopic unit. Except for the larger one, the endoscopy unit should have all conceivable FB gripping forceps and a gastroscope with a diameter of 6 mm [5].

BUTTON AND CYLINDRICAL BATTERY INGESTION

The emergency endoscopic procedure is indicated in children with button batteries stuck in their esophagus because large-diameter batteries lodged in the esophagus can lead to severe complications. Electrolytic activity hydrolyzes tissue fluids producing hydroxide at the negative end of the battery, resulting in alkali injury. Furthermore, the intensity of physical pressure increases the alkali injury (**Fig. 1B, C**). The increased size of batteries and their transformation into lithium cells pose an increased risk of mucosal injury. An alkaline caustic injury, especially with lithium-cell batteries larger than 20 mm, can occur within 30 minutes and last hours or days, resulting in perforation and aortoenteric fistulas [25].

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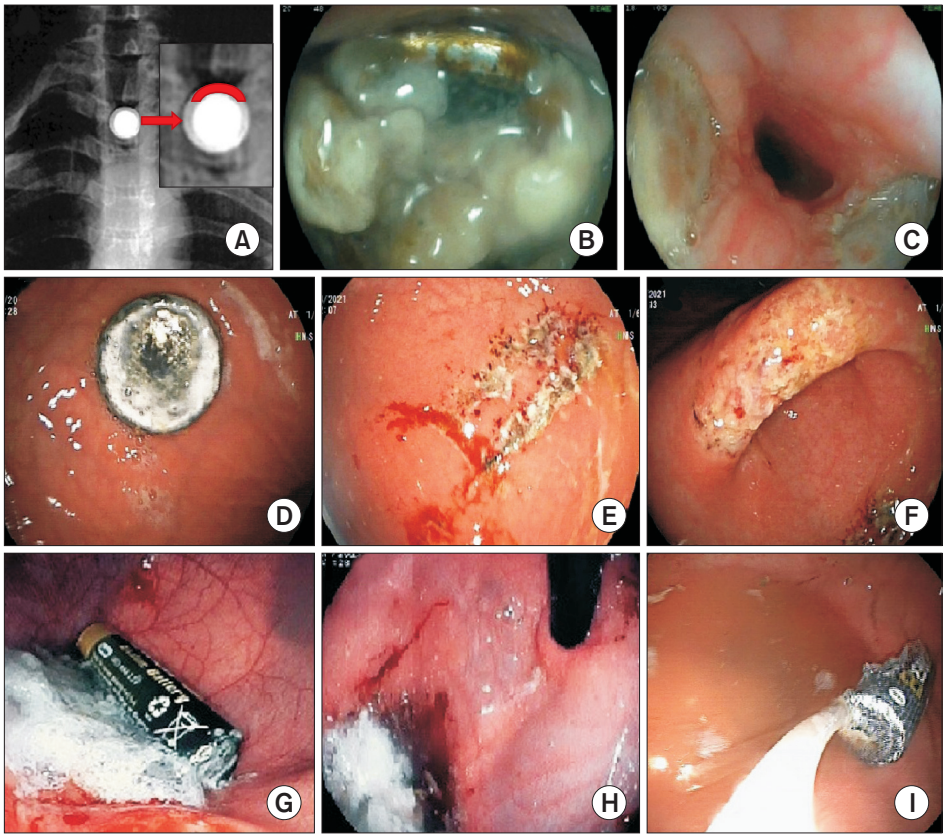

Fig. 1. (A) A button battery on radiograph (double contours/surrounding halo appearance is notable), (B) endoscopic image of the battery and the mucosal mess, and (C) the areas of esophageal mucosal necrosis that were healing during the follow-up endoscopy performed a week after the removal. (D) A button battery >2 cm in the stomach, (E, F) necrotic foci and ulcer area at 3 hours after ingestion. (G, H) Appearance of endoscopy performed at 24 hours after ingestion in a patient who ingested a cylindrical battery, area of erosive foci, and (I) removal by a grasping forceps with a net.

In an extensive study, 0.8% of patients had tracheoesophageal fistula, esophageal perforation, esophageal stricture, vocal cord paralysis, mediastinitis, cardiac arrest, pneumothorax, aortoenteric fistula, and 0.15% died [26].

A complete history of ingested objects is not always recorded. Therefore, radiographs should be carefully examined. It is necessary to determine whether a spherical radiopaque object in the esophagus is a battery. The double-contour (halo) view around the object indicated the presence of a battery (**Fig. 1A**).

Unless the batteries are buried in the mucosa, they can be removed using grasping forceps. It is recommended that the batteries in the esophagus and batteries in the stomach should be removed using rat-toothed forceps and grasping forceps with a net, respectively. The surgeon should use a rigid endoscope if batteries are embedded in the mucosa. A battery in the patient's stomach did not suggest that the patient was safe and the battery could have caused harm to the esophagus before it entered the stomach [27]. Therefore, although the button battery is in the stomach, the danger of esophageal perforation should be considered. Furthermore, if the button battery remains in the stomach without moving, it causes injury to the gastric mucosa [27-29].

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Table 1 [1-4,30] shows the management of ingested batteries. A battery stuck in the esophagus is the most emergency indication for endoscopic removal. Regardless of the NPO guidelines, the endoscopic procedure should be performed emergently by intubation under general anesthesia [2,3,5]. If the patient has a suspicion of perforation or bleeding, a surgeon and a cardiovascular surgeon should perform the endoscopic procedure in the operating room. If there is a suspicious endoscopic appearance after endoscopic removal, symptomatic patients should be evaluated using CT or MRI. If batteries >2 cm in diameter are found in the stomach, especially in young children, they should be removed endoscopically. However, smaller batteries can be clinically monitored.

The ASGE guidelines recommend removing a ≥20 mm battery if it is still in the stomach 48 hours after ingestion [4]. However, the NASPGHAN recommends removal within 24–48 hours based on its algorithm [1]. Contrary to the ASGE and NASPGHAN guidelines, two studies [28,29] reported that gastric batteries, especially those smaller than 20 mm, should be removed within the first 24 hours to reduce complications.

Endoscopy should be considered an emergency in all symptomatic cases, as indicated in the Table. An emergency endoscopy was performed on a symptomatic 2.5-year-old boy who had ingested a button battery >2 cm. Although endoscopy was performed within 3 hours of ingestion, necrotic foci and ulcerated regions were visualized in the stomach (**Fig. 1D-F**).

Despite their large size, cylindrical batteries easily pass through the gastrointestinal tract because of their shape and cause less mucosal injury owing to their structure [31]. The ESGE and the ESPGHAN suggest that if a single cylindrical battery in the stomach is not passed in the stool, the patient can be followed up with radiographs for 7–14 days with a weak recommendation and low quality evidence [2]. However, in the case of a cylindrical battery, attention must be paid to the type of battery, the voltage type (such as A23 or A27), and how long it has been in use [32]. The cylindrical battery in the stomach should be removed within

Table 1. Management of battery ingestion

Clinical scenario	Procedure
Button battery in the esophagus	
· The patient is stable	· Emergent endoscopy
· The patient is unstable or there is bleeding	· Emergent endoscopy by a pediatric surgeon and a cardiovascular surgeon in the operating room
· There is a suspicion of aortic injury (in the presence of bleeding, drop in hemoglobin, extensive and deep ulcer)	· CT angiography or MRI*
· After battery removal	· Treatment and follow-up in terms of corrosive injury and perforation (if symptomatic, CT/MRI scans)
Button battery in the stomach or below	
· Patient aged <5 years and battery ≥20 mm in size	· Endoscopy within 24–48 hours
· There is evidence of esophageal injury	· Initial evaluation by CT
· Patient aged >5 years and battery ≥20 mm in size	· Endoscopy within 48 hours
· Patient aged >5 years and battery <20 mm in size	· Radiographic follow-up and endoscopy if not excreted on days 7–14.
Symptomatic and/or there is a known anatomical pathology	· Emergent endoscopy
Cylindrical batteries	
· In the esophagus	· Urgent endoscopy
· In any part of the gastrointestinal tract and symptomatic	· Urgent endoscopy
· In the stomach or below and asymptomatic	· It can be monitored for 7–14 days
· Multiple cylindrical batteries in the stomach	· Urgent endoscopy

MRI: magnetic resonance imaging, CT: computed tomography.
*MRI scans should not be performed before battery removal.

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24 hours, especially if the patient is symptomatic. **Fig. 1G and H** show gastric hemorrhagic ulceration in a patient who ingested a cylindrical battery. Twenty-four hours after intake, an endoscopy was performed. A large-netted grasping forceps could be used to extract a cylindrical battery (**Fig. 1I**).

MAGNET INGESTION

The greatest risk of ingesting magnets is the binding of the two magnets by intercepting intestinal loops, which can result in enteroenteric fistula, perforation, peritonitis, ischemia, and necrosis.

Rare earth metal magnets composed of neodymium, iron, and boron are more than ten times stronger than standard ferrite fridge magnets [6,33]. These magnets are now frequently used in desk toys and novelty items. Magnet ingestion and associated complications have significantly decreased with the withdrawal of such products from the market [34], only to increase again after the reintroduction of high-power magnet sets into the market [33]. Nevertheless, magnet ingestion is increasing every year, and most cases are unreported. According to a recent survey [35], it is estimated that 50-70 cases of magnet ingestion occur in Japan annually.

According to a large-scale survey, magnet removal was done using 52% endoscopy, 20% endoscopy, and surgery combined, 8% surgery, and 15% observation alone. Of the patients, 41% had no perforation or fistula repair, whereas 22% had various degrees of intestinal resection [1]. Thirty-nine percent of 89 patients who ingested magnets were symptomatic, 40% required stomach surgery, and all patients who required abdominal surgery swallowed more than one magnet or a metal object with the magnet [36].

In the case of magnet ingestion, the following things should be considered: (A) if it is visible on plain radiography, lateral radiographs should be taken to confirm the number; (B) if multiple magnets are ingestion, they should be removed “urgently” even if the patient is asymptomatic; (C) esophagogastroduodenoscopy or colonoscopy should be performed depending on the position of the magnet; (D) although the forceps used for removal may vary depending on the shape and size of the magnet, grasping forceps with a net is ideal; (E) laparotomy or laparoscopy is required in institutions without endoscopy [1]. The management of magnet ingestion is presented in **Table 2** [1,2,4].

Surgery should be considered for symptomatic patients who ingest more than one magnet. **Fig. 2** shows cases of symptomatic presentation direct magnet ingestion. In the first image, there were two magnets, one in the stomach and the other in the duodenum, and in the second image, 17 magnets that caused ileal perforation were seen.

POINTED OR SHARP OBJECT INGESTION

Perforation, extraluminal migration, abscess, peritonitis, fistula, appendicitis, necrotizing fasciitis, liver, bladder, heart, and lung penetration, incarcerated umbilical hernia, common carotid artery rupture, aortoesophageal fistula, and death can result from the ingestion of pins, sewing needles, and safety pins, nails, screws, toothpicks, and bone [37-49]. The average transit time of an object in children is 3.6 days, while the average perforation time is 10.4 days [1,2].

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Table 2. Management of magnet ingestion

Clinical scenario	Procedure
If it is the only magnet	
· In the esophagus or stomach	· It may be removed endoscopically or · If the family cooperates, education (removal of the magnet and metal objects from surroundings and clothes) and follow-up with serial radiographs
· Below the stomach	· Removed by endoscopy if possible, or · Follow-up with serial radiographs and parental education (removal of the magnet and metal objects from surroundings and clothes) · If passage is delayed, accelerate with PEG 3350/other laxatives
Multiple magnets or a metal object ingested with one magnet	
· All in the esophagus or stomach	· Endoscopic removal within the first 12 hr · Referral if endoscopy is not possible · Consulting surgery if transfer >12 hr · Surgical intervention if endoscopic removal is not successful
· Below the stomach	
Symptomatic	· Surgery
Asymptomatic	· If there are no signs of obstruction and/or perforation on the radiograph, endoscopy (enteroscopy/colonoscopy) or · Follow-up with radiograph every 4–6 hr · If there is no progress, administration of PEG 3350/laxative · If not, endoscopy · If still not removed, surgery

PEG: polyethylene glycol.

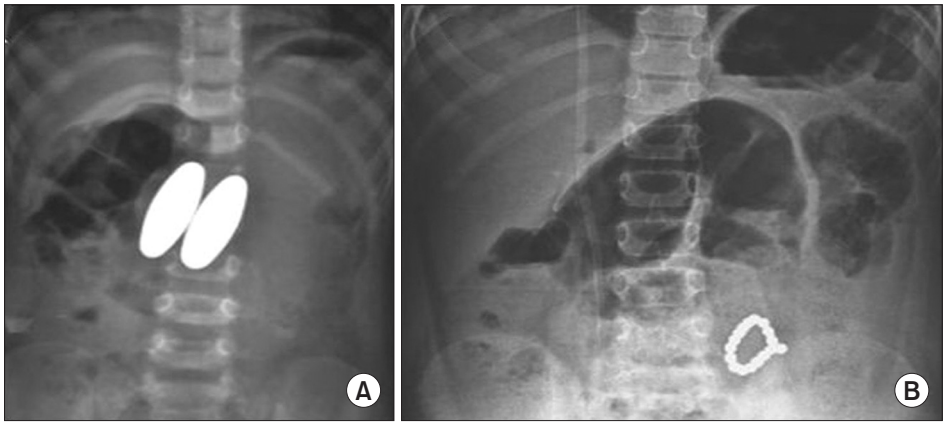

Fig. 2. (A) Two magnets, one in the stomach and the other in the duodenum, (B) 17 magnets that caused ileal perforation.

Appropriate protective equipment, such as an overtube, protective cap, or distal transparent caps used for band ligation, is recommended to protect the esophagus from trauma during endoscopic removal. A direct laryngoscope is an alternative removal tool for objects in the cricopharyngeal area [2].

If an asymptomatic sharp object is found in the esophagus or stomach, it should be removed within the first 24 hours after proper NPO condition. During an endoscopic procedure, it may be difficult to locate and grab, such as an object in a stomach full of food. If the patient is symptomatic, the object should be removed emergently, as with other FBs. **Table 3** [1-4] shows how to manage cases of ingestion of a sharp object.

Safety pins are among the most commonly ingested FBs in several parts of the world, especially in infants. Complications of safety pin ingestion include carotid artery rupture,

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Table 3. Management of pointed object ingestion

Clinical scenario	Procedure
Radiopaque	
· In the esophagus	· Emergent/urgent endoscopy
· In the stomach	· Urgent/emergent endoscopy
· In the small intestine (if under Treitz lig)	
Symptomatic	· Enteroscopy or surgery
Asymptomatic	· Clinical follow-up with serial radiographs
	· Surgery if the patient becomes symptomatic or the object is not removed/passed out for more than 3 d
Radiolucent (foreign body thought to have been ingested by self-statement/witness statement)	
Symptomatic	· Emergent endoscopy
Asymptomatic	· Endoscopy if evidence of esophagogram or CT; clinical follow-up if there is no evidence of esophagogram or CT

CT: computed tomography.

hemopericardium, cardiac tamponade, duodenocolic fistula, and incarcerated umbilical hernia [50-53]. While approximately 30% of cases were operated by surgeons during follow-up [54], Almost all of the safety pins, which can be achieved by flexible endoscopic procedures performed by pediatric gastroenterologists, are easily removed [55,56]. Because safety pins are easily removed endoscopically, it may be suggested that the best option is to remove the safety pin using endoscopy while it is still in the esophagus and stomach.

In some regions, fishbone was the most commonly ingested FBs by children, and fishbones were removed by scope in 59% of 416 children [57].

ESOPHAGEAL FOOD IMPACTION

Food impaction is the most common esophageal FB found in adults [4]. Furthermore, it is commonly observed in children with eosinophilic esophagitis, reflux esophagitis, post-anastomotic stenosis after tracheoesophageal fistula repair, achalasia, and other motility disorders. In endoscopy, an overtube is very useful in adults; however, its usage in children is a risk of perforation. During the endoscopic procedure, biopsies should be taken from the esophagus for eosinophilic esophagitis, and patients should also be evaluated for stenosis [1,2].

Acceptable methods for managing esophageal food impactions have been proposed, including en bloc removal, piecemeal removal, and gentle push technique [4]. If the patient cannot tolerate secretions, endoscopic procedure should be performed emergently as removing or gently pushing. If the patient tolerates secretions, endoscopic removal should be performed urgently together with adequate preparation and/or possibility of spontaneous passage [1-3].

COINS AND BLUNT OBJECT INGESTION

Coins should be removed from the esophagus within 24 hours. First, coins should be distinguished from batteries on radiographs. In the case of battery ingestion, a double contour appearance on the edge was visible. A lateral radiograph can be taken to be sure. In younger children, objects >2.5 cm in diameter cannot pass through the pylorus, while objects >6 cm cannot pass through the duodenum. Therefore, such large and long objects should be removed, even if they are in the stomach [1-4].

For coins and other blunt objects in the esophagus, rat-toothed forceps are appropriate, and grasping forceps with a net are suitable for those in the stomach. If the coin is stuck horizontally in the esophagus, symptoms such as hypersalivation and difficulty swallowing

may occur. If endoscopic removal is impossible, the coin may be moved vertically using a nasogastric tube. The coin may fall into the stomach during this procedure, in which case the urgency of the treatment is no longer necessary. In some institutions, a coin in the upper esophagus is extracted with a Foley catheter under anesthesia and fluoroscopy. Before extracting the FB from the esophagus using a nasogastric tube or Foley catheter, care should be taken to ensure that the FB is not a button battery. A coin-size button battery may have been buried in the mucosa, causing esophageal necrosis, which may have resulted in perforation due to interference with tube or catheter.

If the coin is symptomatic, it should be removed emergently; otherwise, it should be done as soon as possible. If a coin is in the stomach or below, it may remain for a few weeks. However, endoscopy may not be conducted in the stomach if its diameter is >2.5 cm. Laxatives can be very effective for coins and other blunt objects in the stomach, as well as sharp objects in the stomach, especially below the stomach. **Table 4** [1,2,4] shows the management of ingested coins and blunt objects.

A child who ingested 28 glass marbles with a diameter of 1 cm was discharged with clinical follow-up; **Fig. 3A and B** shows that all the marbles were defecated within 24 hours. Marbles are radiopaque on radiograph because they have been colored.

SUPERABSORBENT OBJECT INGESTION

Polymers that can expand 100–200 times in water are superabsorbent materials. Diapers, feminine hygiene products, agriculture, and the entertainment industry (toys such as water polo and tabletop ornaments) all use them. Their management is difficult because they are radiolucent and pass quickly through the proximal GI tract without getting large enough to cause obstruction. A small number of cases of intestinal obstruction have been reported, one of which resulted in death due to postoperative sepsis [58-62]. A study [63] reported that 21 asymptomatic children who ingested a superabsorbent object did not undergo endoscopic or surgical procedures and did not develop signs of obstruction during their follow-ups.

Fig. 3D shows that a hard-textured object obstructing the jejunum is seen on endoscopy of a 2-year-old patient who was admitted with persistent vomiting. The surgically removed object (**Fig. 3E**) was a superabsorbent object of unknown origin, approximately 5 cm in diameter (**Fig. 3F**).

In our country, the ingestion of superabsorbent objects such as water balls and water apes is anecdotally common, although they have not been published. Proposals based on our

Table 4. Management of coin and blunt object ingestion

Clinical scenario	Procedure
In the esophagus	
Symptomatic (unable to tolerate secretions)	· Emergent endoscopy
Asymptomatic	· Urgent endoscopy · Radiographs should be taken again before the endoscopy (it may have fallen into the stomach)
In the stomach	· It may be expected · If it is not passed in the stool and if it is not symptomatic, it may be followed up with radiographs at 1–2 wk intervals/ laxative if necessary · Elective endoscopy if it is not passed out within 2–4 wk
In the small intestine	· Clinical observation/if it becomes symptomatic, endoscopy or surgery

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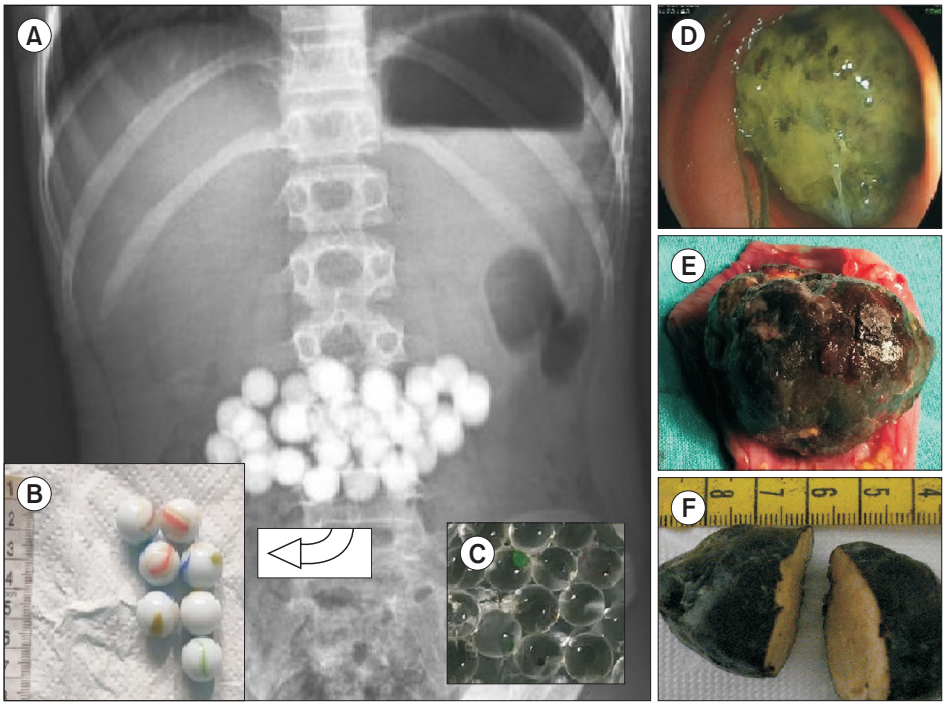

Fig. 3. (A, B) X-ray and post-exit images of ingested glass beads. (C) Superabsorbent water balls. (D) A large superabsorbent object at endoscopy and (E, F) after surgery.

personal experience include the following. If available examining a sample of the ingested object provides information about the potential risk and can help design the endoscopy approach. Endoscopy would be appropriate for objects that can reach a size that could cause obstruction in the GI tract and have hard tissues. **Fig. 3C** shows the samples of the water balls ingested by the patient. Although they remained for hours, they were <1 cm in diameter, and there were no complications in the clinical follow-up of the patient who did not undergo endoscopy. Endoscopy may not be considered for a superabsorbent object with a diameter of 1 mm to 1 cm. If the volume of a spherical object increases 200 times and its diameter reaches 2 cm diameter, its initial diameter must be 3.42 mm. Therefore, endoscopy may be prioritized for superabsorbent objects with an initial diameter >3.42 mm.

CONCLUSION

In conclusion, timely endoscopic procedure for GI FBs can save lives and prevent difficult-to-manage morbidities. Therefore, if a patient presents with blunt or sharp objects, such as batteries, multiple magnets or one magnet together with a metal object, and FBs that cause obstruct the esophagus, and present with increased secretion, the objects should be removed emergently. Other FBs in the esophagus, sharp or pointed objects in the stomach, two magnets, or one magnet together with a metal object in the stomach should be urgently removed. The removal of the remaining FBs should be considered optional. However, symptomatic FB should be removed immediately.

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