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Gastrointestinal Foreign Bodies: Risk Factors, Management, Devices and Implications

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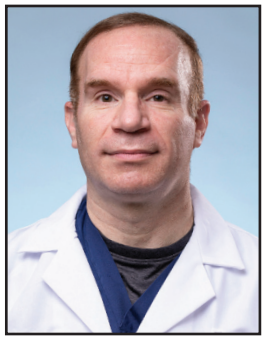

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INTRODUCTION

Foreign body ingestion (FBI) is frequently encountered by adult and pediatric gastroenterologists. More than 100,000 to 150,000 reports of FBIs are reported in the United States yearly.[1,2,3] The frequency of FBI incurs a significant financial burden to the healthcare system. The mean cost for endoscopic removal of foreign body (FB) per case ranges from $3,000 to $14,000 dollars depending on whether hospital admission is required with costs varying state-by-state.[4,5] A healthcare cost analysis of recurrent FBI in the incarcerated population showed that greater than 6 billion dollars are spent annually on FB management in this population alone.[5,6] While FBIs are frequently encountered in the adult population, the vast majority (80%) of FBIs occur in the pediatric population between the ages of 6 months to 6 years.[7-9] According to the American Association of Poison Control Centers, a total of 94,051 cases of FBI occurred across all age groups in 2019. This included 67,186 cases in children younger than 5 years and 12,223 cases in adults aged 20 or older.[10]

While FBI proves costly to the healthcare system and increases the burden of endoscopic procedures, most foreign bodies (FBs) do not require endoscopic intervention. Based on prior case series, less than 10-20% of ingested FBs require endoscopic intervention and pass spontaneously without complication with surgical intervention required in <1%.[11,12] The rates of endoscopic and surgical intervention appear to be higher among patients with intentional FBI, 63-76% and 11-16%, respectively.[13,14] Among FBs that do not pass spontaneously, flexible endoscopic removal remains the gold standard for FB removal with a > 95% overall success rate.[15-20] The aim of this review article is to comprehensively evaluate risk factors, frequent and infrequent FBIs, adverse events (AEs), diagnosis, and management of FBI.

Risk Factors

There are various risk factors that are associated with FBI. In the pediatric population, the major risk factor is simply age and developmental state.

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Most FBIs occur between 6 months to 6 years and are typically accidental. A case series of pediatric FBI at a European tertiary center reported that more than 90% of serious AEs occurred in children 5 years of age or younger.[21] In the adult population, the major risk factors for unintentional non-food FBI include individuals with developmental delay, intoxication with alcohol or illicit/prescription drugs, poor dentition/edentulous/dental prostheses, visual impairment, cognitive disorders, psychiatric disorders, and those who are incarcerated.[9,13,14,22,23] Individuals with psychiatric disorders, particularly borderline personality disorder and incarcerated individuals, are at the highest risk for intentional and recurrent FBIs.[6,24]

Location of Retained Foreign Bodies

It is essential to understand that FBI and FB retention frequently occur in the setting of pre-existing medical conditions. The location of retained FBs occur often in areas of gastrointestinal tract angulation or physiologic narrowing. These areas include the cricopharyngeal muscle, upper esophageal sphincter, esophagus as it traverses the aortic arch approximately 25 cm from the incisors in adults, lower esophageal sphincter/gastroesophageal junction, pylorus, duodenal sweep, ileocecal valve, and anal sphincter.[25] Other pathologic structural abnormalities that increase risk of FB retention include benign and malignant strictures, mass lesions, motility disorders (i.e. achalasia), chronic inflammatory disorders (i.e. eosinophilic esophagitis), GERD, neuromuscular disorders, prior gastrointestinal tract surgery, and congenital gastrointestinal tract malformations.

Diagnosis and Initial Management

The history and physical examination are key in the initial evaluation of a patient with a suspected FBI. It is vital to ascertain the type of FB including the character (sharp vs. blunt), size (long, short, wide), and whether the FB is capable of causing tissue penetration, pressure necrosis, chemical corrosion, or mechanical trauma. While clinical symptoms may be useful if severe, most patients remain asymptomatic or have only mild symptoms including sore throat, globus, or chest discomfort. Symptoms can often have a delayed onset after FBI.[26] Other symptoms and clinical signs may be present including dysphagia, odynophagia, inability to eat, intolerance of secretions, nausea, vomiting, abdominal pain, peritonitis, mediastinitis, crepitus in the chest and neck, and neck swelling or pain based on the site of the FB.[27]

In contrast to the pediatric population, most adults present with symptoms of FBI, particularly those with food impactions (FIs). FIs are the most common FBIs in the adult population with underlying eosinophilic esophagitis and Schatzki's rings as the most common etiologies.[28] Meat impactions (pork, beef, and chicken) are the most common culprits with the distal esophagus being the most common location.[28] Adults typically present with symptoms of globus, dysphagia, and chest pain if the FB is present or has recently passed from the esophagus.[29] However, a prospective study showed that patient localization of a FB based on symptoms was poor, especially below the cricopharyngeal muscle. Patient localization of FB location based on symptoms was improved for FBs above the cricopharyngeal muscle.[30] Symptoms may be unreliable in young children and adults with altered mental status, cognitive deficits, or intoxication. Examination and collateral history are important to determine if serious AEs have occurred from the FB.

Imaging Studies

Chest X-ray/Abdominal Plain Films (KUB) are useful radiologic diagnostic tools to allow rapid evaluation and localization of metallic and the occasional osseous FB (i.e. bones). X-rays are also helpful to exclude an aspirated FB in the airway. Cross-sectional imaging including computed tomography scan of the neck, chest, abdomen and/or pelvis is particularly useful for FB localization and comprehensive evaluation of potential AEs including perforation, fistula formation, pneumothorax, retropharyngeal abscess, and gastrointestinal bleeding. These studies allow rapid characterization and localization of the FB that can inform the timing and approach of endoscopic evaluation and often suggest which tools might be best suited to removal of the FB in question. While metallic FBs such as metal objects and osseous objects are hyperintense on CT, other non-metal objects such as glass, plastic, wood, thin metallic objects and thin bones such as fish

or chicken bones, may not be readily visible even on CT.

CT has been shown to have a higher sensitivity and specificity (100 and 94 %, respectively) than conventional radiographs for identification of esophageal FBs.[32] More advanced helical 3D-CT scans have also been reported to be more useful than traditional imaging in difficult FBs that could not be identified by conventional imaging, but this technology may not be universally available.[33] Imaging remains a useful radiologic tool after FBI given frequent unreliability of patient reported symptoms particularly in patients who are obtunded, have altered mental status, or cognitive impairment.

Types of Foreign Bodies (True vs. Food foreign bodies)

Sharp Foreign Bodies

There are numerous sharp/pointed FBs that have been previously described. These include razor blades, needles, fish or meat bones, dental prosthesis, nails/screws, bread bag clips, glass, sharp pencils/pens, pins of various kinds, glass drug paraphernalia, and paper clips. (Figure 1 and Table 1) These objects are of high-clinical concern, especially when lodged in the esophagus due to risk of AEs prior to, during, and after endoscopic removal. Sharp esophageal FBs are considered a medical emergency and need immediate attention. Determining the location and type of FB is paramount. While radiologic examination is helpful in certain types of metallic and osseous FBs, small sharp objects may not be visible, or may be challenging to detect, on Chest X-ray, KUB, or CT scan. Thus, endoscopic evaluation should be undertaken when there are concerns of sharp FBI despite negative radiologic evaluation. The majority of sharp objects that reach the stomach usually pass without complication; however, the AE rate, including perforation, has been reported to be up to 15-35% with sharp foreign bodies.[34]

The overall perforation rate of non-sharp FBs remains <1%.[34,35] AEs from sharp objects include mucosal erosion, ulceration, gastrointestinal bleeding, fistulization, and perforation. Thus, urgent endoscopic removal of sharp FBs, even if they pass into the stomach, is warranted. If

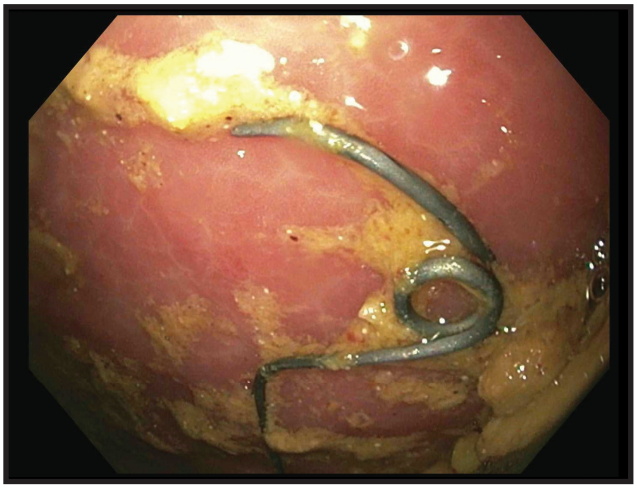

Figure 1. Bent safety pin in stomach – a sharp foreign body. The object was removed with an endoscope hood and a rat-tooth forceps.

Figure 2a. Ingested AA Battery in stomach

Figure 2b. Battery removed with a snare

Table 1. Classification of Foreign Bodies

Type	Examples
Sharp	Razor blades, needles, fish or meat bones, dental prosthesis, nails/screws, bread bag clips, glass, sharp pencils/pens, pins of various kinds, glass of drug paraphernalia, and paper clips
Short Blunt	Coins, buttons, batteries, toys, and magnets
Long Blunt	Toothbrushes (particularly travel toothbrushes), blunt sewing needles, and eating utensils
Food Bolus Impaction	Meat impactions (steak, chicken, pork, fish) with or without sharp foreign bodies including fish bones, chicken bones, and toothpicks
Other	Illicit/caustic substances (narcotic packets, poisons), infectious foreign body, small bowel foreign body

endoscopic intervention is not able to be safely performed and the object is persistent on imaging, surgical consultation and intervention should be considered.[14,35]

Given the relatively high AE rates of sharp FBs, frequent clinical examination of the individual is warranted. Individuals should be counseled extensively on rapid reporting of symptoms including acute onset of abdominal pain, abdominal distention, gastrointestinal bleeding, chest pain, shortness of breath, and fever/chills as these could signify major AEs. Endoscopic devices utilized for sharp FBs include (but are not limited to) grasping forceps, retrieval nets, polypectomy snares, baskets, latex rubber retrieval hoods, transparent endoscopic caps, and overtubes. (Table 2)

Short Blunt Foreign Bodies

Short blunt FBs (measuring < 2-2.5 cm) most commonly include coins, buttons, batteries, toys, and magnets. Ingestion of coins, toys, and buttons are more common in the pediatric patients. (Figure 2) For short-blunt FBs, endoscopic approaches are recommended for removal given excellent visualization of the FB and evaluation of underlying disease processes leading to FB impaction. As previously summarized in the ASGE guidelines on FB management, non-endoscopic means of FB removal have limited efficacy data and patient safety concerns associated with this approach.[14] The size of short blunt foreign objects may lead to prolonged retention in the stomach or the duodenum. Objects larger than 2.5 cm in diameter are likely not to pass through the pylorus. Non-emergent endoscopic removal of these objects is warranted if not passed in 3-4 weeks per ASGE guidelines although the data regarding timing of removal is limited.[14] In individuals with retained short blunt FBs in the duodenum, retention after 1 week should be considered for endoscopic removal. If the retained duodenal FB is out of endoscopic reach, surgical intervention should be considered. Emergent surgical evaluation should be pursued in any individual with signs of peritonitis from a retained short blunt FB.

Table 2. Type of endoscopic device used for specific foreign bodies

Type of Foreign Body	Endoscopic Device
Sharp Foreign Body	Grasping forceps, retrieval nets (Roth Net/Rescue Net), polypectomy snares, baskets, latex rubber retrieval hood, transparent endoscopic caps, overtubes OTSC Xcavator
Short Blunt Foreign Body	Grasping forceps (coins, disc/button batteries), Roth Net/Rescue Net, baskets, polypectomy snares, esophageal balloon (disc/button batteries), OTSC Xcavator
Long Blunt Foreign Body	Polypectomy snares, baskets, and in rare instances sphincterotomes
Food Impactions	Endoscope – "push technique" Grasping forceps (raptor graspers, rat-tooth forcep, alligator grasper, talon grasper), polypectomy snare, Roth Net/Rescue Net, endoscopic cap with suction, OTSC Xcavator
Infectious Foreign Body	Grasping forceps (cold forceps, rat-tooth/alligator forceps, raptor graspers) with endoscopic cap
Small Bowel Foreign Body	Push enteroscopy, single-balloon enteroscopy, double-balloon enteroscopy, polypectomy snares, colonic dilation balloons

Figure 3a. Cluster of swallowed plastic spoons

Figure 3b. Spoons removed individually with a rat-tooth forceps

1. Coin Ingestion

Coin and toy ingestions have been seen in adults, particularly in those with alcohol intoxication and psychiatric disease.[36] Coin ingestions typically can undergo expected management for 12-24 hours in asymptomatic patients as spontaneous passage is common.[37] Expected management in these situations may potentially avoid unnecessary anesthesia, endoscopic, and surgical evaluations. Coins lodged in the distal esophageal pass into the stomach at a higher rate than those lodged in the proximal esophagus (56% and 27%, respectively).[38] Individuals with coin ingestion with symptoms including stridor, chest pain, or intolerance of secretions/drooling should undergo emergent evaluation due to concern for airway compromise and esophageal AEs.[14] In rare case reports, massive coin ingestions can lead to zinc toxicity in pennies minted after 1982.[39,40] Excessive and prolonged zinc exposure can lead to copper malabsorption and deficiency resulting in hematologic and potentially irreversible neurologic AEs.[41] Endoscopic removal of coins is typically achieved with Roth Nets/ Rescue Nets, rat-toothed or alligator forceps, or polypectomy snares.[35]

2. Magnet Ingestion

Magnets are of particular concern as these FBs can lead to serious gastrointestinal AEs. When multiple magnets or a magnet and another metal object are ingested, they may attract each other, trapping hollow organs between the magnets. This may result in stomach or bowel necrosis, volvulus, obstruction, and fistulization.[42] When only one magnet is ingested, this usually does not pose any significant risk due to lack of attraction to other objects. However, if a limited clinical history is available and the potential for ingestion of other metal objects or stacking of magnets is possible, removal of any number of magnets is recommended.[14,43] The delay in diagnosis may lead to otherwise preventable serious AEs and surgical intervention. If the magnets can be retrieved endoscopically, this is ideal, but in some cases the magnets are too strong to be separated and must be removed manually via surgery.

3. Battery Ingestion

Battery ingestion poses the potential of serious AEs particularly when impacted in the esophagus. Disc or button battery cs are more common in children <5-6 years of age.[44,45] Disc or button battery ingestions can cause rapid injury, particularly in the esophagus. Due to the narrow lumen allowing

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mucosal contact with each pole of the battery or from battery leakage, electrical burns from liquefactive necrosis can lead to perforation and/or fistula formation.[46] Esophageal damage can occur within 2 hours of ingestion of disc or button batteries with full corrosion potential reaching its peak at 12-24 hours.[47] Greater than 50% of serious AEs due to button battery ingestion occur after unwitnessed ingestion leading to a delay in diagnosis.[44,45] Disc and button batteries in the esophagus should be removed on an emergent basis due to the risk of serious AEs and death associated with delay in removal. Disc or button batteries that cannot be removed from the esophagus should be advanced into the stomach where they can be removed with a Rescue Net or basket.[14] Once in the stomach, these batteries can be observed for up to 48 hours if there is no concern for gastrointestinal injury. Per ASGE guidelines, any battery 20 mm or greater retained in the stomach for more than 48 hours should be removed endoscopically.[14] Once past the duodenum, more than 85% of batteries will pass spontaneously within 3-4 days.[48] Frequent abdominal radiographs are often performed to confirm passage. It should be noted that disc batteries may resemble, or be confused with, coins radiographically. There are two main distinctive differences to help differentiate coins vs. a disc battery. Disc batteries usually have a double-density shadow or halo due to the bilaminar structure of the battery. Disc or button batteries may also have a "step-off" or notches at the junction between the cathode and anode at the ends of the battery. Coins typically have a uniform density with no step-off or notching on the perimeter of the coin.[49] Twenty mm and 25 mm disc batteries have a higher propensity to get lodged in the esophagus. Lithium batteries tend to come in higher voltage than alkaline batteries (3V vs. 1.5V), which can increase the current that is generated across mucosal tissue.[50] Cylindrical battery ingestion is less common and appears to have a more benign clinical course. Typically, mucosal injury occurs where battery integrity has been compromised. Obtaining a history of whether the battery was compromised prior to ingestion can help triage of endoscopic evaluation. In a retrospective study, less than 18% of patients experienced symptoms

Figure 3c. Large nasal trumpet in stomach

associated with cylindrical battery ingestion.[44]

There is minimal to no role of medical management for battery ingestions. Acid blocking therapy has not been beneficial to neutralize corrosion.[44] Laxatives may help expedite GI transit, although otherwise have a limited role. Emetics also have not been recommended due to concern for retrograde transit of batteries into the esophageal lumen.[44] Endoscopic removal of batteries can be achieved by multiple devices. For cylindrical/button batteries in the esophagus, an esophageal balloon can be inflated distal to the battery and retracted with the balloon inflated. General anesthesia would be required for this technique for airway protection. Other devices commonly used for cylindrical batteries include baskets, rescue nets, and polypectomy snares.

Long Blunt Foreign Bodies

Long blunt FBs mainly consist of toothbrushes (particularly travel toothbrushes), blunt sewing needles, and eating utensils. (Figure 3) These foreign bodies often measure >6 cm in length. Given their length, these items are likely to be retained in the stomach due to the relatively small diameter of the pyloric channel. These FBs need to be considered for removal on an urgent basis as the risk of perforation in up to 15-35% of cases.[51] Based on a retrospective case series, 80.5% of foreign bodies longer than 6 cm were retained proximal to the pylorus at the time of endoscopy. Greater than 60% of these endoscopies were performed

Figure 3d. Nasal trumpet after removal, with adult male hand for scale

Figure 4. Food bolus (meat) impaction in esophagus

more than 48 hours after presentations suggesting large blunt objects >6 cm have a propensity to be retained in the stomach.[13] Removal of long-blunt FBs can be achieved with a combination of devices. Long overtubes (>45 cm) that extend into the stomach and silicone hoods can be used to protect the esophagus during FB removal. Typically, polypectomy snares, baskets, and in rare instances sphincterotomes can be utilized. In our experience, fingernail clippers can be removed with bowing of the sphincterotomy and pinning the FB to the scope for removal. Snare removal can be performed although can be difficult at times due to the tapered end of nail clippers.

Food Bolus Impactions

Food impactions (FI) is the most common non-true foreign body encountered in adult patients. (Figure 4) The annual incidence of FI is 13 episodes per 100,000 individuals with a mean age of 46.5 years.[52] The most common impactions include meat impactions (steak, chicken, pork, fish) which may be accompanied by sharp FBs including fish bones, chicken bones, and toothpicks. Food impactions appear to be more common in males than females based on retrospective analyses.[52,53] Common symptoms include dysphagia, odynophagia, sialorrhea, chest pain, and nausea and vomiting. FIs are frequently accompanied by underlying esophageal conditions. Sialorrhea and odynophagia have been shown to be predictive factors for a complete FI.[54] The most common etiologies include eosinophilic esophagitis and peptic strictures. Other less frequent conditions include Schatzki's rings, radiation-induced strictures, esophageal malignancy, and achalasia.[17,52,53]

Given the high rate of underlying pathology, there has been debate regarding the optimal method of FI removal. The gentle advancement of the food bolus to the stomach, referred to as the "push technique," was previously recommended, although some have raised concerns that this may increase the risk of iatrogenic perforation. Retrospective case series have shown that the push technique is relatively safe with resolution of the FI in 97-98% of cases without AEs.[55,56] Both the ASGE and ESGE FB removal guidelines support this technique with a few qualifications. It is recommended that the endoscope be advanced beyond the FI (if feasible) to assess for underlying esophageal pathology prior to employing the push technique.

If the FI cannot be gently advanced, then is it advised to reduce the FI burden with grasping devices prior to advancement of the food bolus into the stomach to reduce perforation risk. Advancing the endoscope to the right side of the impaction may provide easier access to the stomach as the GE junction often angulates to the left of the patient.[14,51]

Other endoscopic means of removing FIs include grasping devices (raptor graspers, rat-tooth graspers, alligator graspers, talon graspers),

Table 3. Timing of Endoscopic Evaluation for Foreign Body Ingestion

Foreign Body Object	Location	Timing of Endoscopy Emergent: Next available Urgent: Within 12-24 hours Nonurgent: Within 48-72 hours
Sharp Body Object	Esophagus Stomach Small bowel	Emergent Urgent Urgent
Short Blunt Body Object (non-battery)	Esophagus Stomach Small bowel	Urgent Nonurgent Nonurgent
Battery	Esophagus Stomach Small bowel	Emergent Urgent Urgent
Long Blunt Body Object	Esophagus Stomach Small bowel	Urgent Nonurgent Nonurgent
Food Impactions	Esophagus	Emergent (Complete food impaction) Urgent (Incomplete food impaction)
InfectiousBody Object	Esophagus Stomach	Non-urgent (unless complete obstruction - emergent) Non-urgent (unless complete obstruction - emergent)
Video Capsule Endoscopy in the Small Bowel	Small bowel	Nonurgent – if asymptomatic Urgent – if symptomatic (i.e. abdominal pain) Emergent – (if obstructive symptoms without peritonitis) *If concern for perforation or ischemia, consider surgical consultation

Net/Rescue Net (particularly for "ball-valving" impactions), baskets, polypectomy snares, and endoscopic cap suction removal, all of which "pull" the food bolus out rather than "push" it. Newer devices such as the OTSG Xcavator developed by Ovesco Endoscopy have been mainly utilized for pancreatic necrosectomy, but can be used for FB removal. This device has shown success and promise in FB removal, although data is limited at this time.[57]

Glucagon has been long-used as a medical therapy and adjunct in FI management given its spasmolytic properties. Studies have shown variable success rates with glucagon for FIs. A few retrospective studies showed no improvement of glucagon and benzodiazepine administration over placebo in individuals with FIs particularly in individuals with fixed esophageal obstructions.[58,59] Meat impactions were also less likely to respond to glucagon in one study.[59] Another retrospective study showed up to 33% effectiveness with glucagon, similar to prior placebo-controlled studies, however no placebo group was included in this study.[60] While some believe glucagon to be a safe adjunct to FI management, glucagon can cause nausea and vomiting and increase risk of aspiration and perforation in the setting of a severe/complete FI.[51]

Illicit Drug Packets

Ingestion of illicit drug packets is a common phenomenon in emergency medicine and gastroenterology. Illicit drug packet ingestions have been seen in both the adult and pediatric populations for drug trafficking purposes.[61] These

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illicit substances are typically packaged in plastic wrapping and latex balloons and/or condoms. Oral ingestion is known as "body packing" and "body stuffing" refers to rectal or vaginal concealment for drug trafficking purposes. "Body stuffing" is often utilized by individuals for rapid internal concealment during law enforcement apprehensions.[62] Illicit substances frequently encountered from body packing or body stuffing include packets of heroin, cocaine, 3,4-methylenedioxymethamphetamine (MDMA), marijuana, and fentanyl. Drug packets are frequently encountered radiographically on abdominal radiographs or computed tomography scan. CT has a high diagnostic accuracy, sensitivity, and specificity for drug packet ingestion (97.1%, 100 %, and 94.1%, respectively).[63]

With respect to endoscopic evaluation for illicit drug packet ingestions, the ASGE and ESGE do not recommend endoscopic retrieval of illicit drug packets due to the risk of drug packet rupture, which can be fatal due to rapid drug entry into the systemic circulation. If there is failure of passage of drug packets, evidence of bowel obstruction, or suspicion of drug packet rupture and toxicity, emergent consultation with poison control, medicine, and surgery are warranted.

Infectious foreign bodies

Infectious foreign bodies are exceedingly rare particularly in the United States. However, these may be more common particularly in East Asian countries. In Japan, a parasitic nematode known as Anisakis, which is found in undercooked or raw seafood, is known to attach in the walls of the gastric and esophageal mucosa. This can present as esophageal and gastric obstruction and warrant endoscopic removal. Endoscopic removal with biopsy forceps with or without a cap has been used to remove these parasites from the gastric or esophageal mucosa.[64] Ascaris worms are sometimes removed from the small bowel lumen or the bile ducts as well.

Small bowel foreign bodies

Small bowel FBs are considered FBs outside the reach of standard upper endoscopes. These include FBs distal to the third portion of the duodenum or proximal to the terminal ileum (which can be reached with a colonoscope). Common FBs that can become lodged in the distal small bowel include video capsule endoscopes, particularly at sites of stricturing disease or post-surgical anatomy, and migrated biliary stents.[66] Other reported FBs include coins, drug packets, and penetrating fish bones, which have the potential to lead to bowel obstruction and/or perforation. Fish bone ingestion is far more common in Asia than the USA due to dietary patterns. Endoscopic management appears safe and effective for small bowel FBs but special endoscopes and tools may be required to achieve success.[66] Single and double-balloon enteroscopy has been employed in patients with deep small bowel retained foreign bodies. Case reports of successful endoscopic retrieval of retained video capsule endoscopes by either snare extraction or endoscopic dilation have been reported.[65,66,67]

The decision regarding anterograde or retrograde enteroscopy approach depends on the location, shape, size, geometry of the retained FB, and endoscope availability. A systematic review of double-balloon enteroscopy for the retrieval of retained small bowel video endoscopies showed a pooled successful retrieval rate of 86.5% (95% confidence interval, 75.6-95.1%) with a higher success of the anterograde approach vs. retrograde approach (74.7% vs. 26.3%, $p < .001$).[68] In cases where the small bowel FB cannot be reached or the patient has clinical signs or symptoms of peritonitis or perforation, surgical evaluation is warranted.

Management

Airway

There is a general consensus that during FB removal and food bolus extraction, general anesthesia with endotracheal intubation should be undertaken if there is a high aspiration risk (intolerance of secretions, full stomach, foreign body in the proximal esophagus). While the ASGE guidelines state that conscious sedation can be utilized for most cases of adult FBI, with the more frequent use of propofol, deep sedation or general anesthesia is more often currently employed in clinical practice where available.[14] Airway protection can also be achieved with the use of short and long overtubes.

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Timing of Endoscopic Evaluation

The type and nature of the FB guides the determination of the timing of endoscopic evaluation as well as the endoscopic devices that are required for safe and efficient removal. (Table 2 & 3) While removal of the FB is imperative, preventing AEs is paramount. AEs with FBs can occur due to delay in care (i.e. delay in time to presentation to endoscopic evaluation) or during endoscopic evaluation/intervention. The most serious AEs include airway obstruction, esophageal perforation, retropharyngeal abscess, tracheoesophageal fistula, aorto-esophageal fistula and hemorrhage, mediastinitis and pneumothorax. Timely evaluation of individuals with suspected FBI is critical to reduce potential AEs of the retained FB prior to, during, and after endoscopic evaluation and intervention. Retrospective and consecutive case series identified that a FB impacted at the cricopharyngeal muscle or upper esophagus, positive cervical radiographic findings, type and size of FB, duration of the impaction, and delayed presentation more than 24-48 hours were independent risk factors associated with the development of AEs after FBI.[17,31,69]

Endoscopic devices

There are multiple devices utilized in the endoscopic management of FBs. Which endoscopic device that is employed for endoscopic retrieval depends on the nature of the ingested FB. (Table 2) There may be variability among gastroenterologists regarding the choice of endoscopic device for a specific FB based on individual experience and device availability.

1. Latex rubber retrieval hood

For short sharp FBs, endoscopic latex rubber retrieval hoods have been frequently used for safe and effective FB removal due to ease of setup and utilization. These hoods allow the sharp object to be grasped and then pulled through the esophagus while inside the protective hood without risk to the surrounding esophagus. FB hoods may not be universally available, however, makeshift modifications using more readily available materials have been reported. Endoscopic latex hoods constructed from latex gloves attached to the end of the endoscope have been described.[70] This makeshift modification can mimic the function and application of a latex FB hood, however, the thickness of the protective barrier of the conventional latex FB hood is likely superior to that of one constructed from a latex glove.

2. Overtube

For long sharp FBs, long overtubes can be used to protect the esophageal mucosa from injury upon FB removal. Long overtubes can be positioned distal to the gastroesophageal junction and allow passage of the sharp FB from the stomach directly into the overtube where they can do no harm to the esophagus itself. Additionally, overtubes provide airway protection in the unintubated patient particularly when multiple esophageal intubations are indicated. Scenarios where a long overtube (45-60 cm) is desirable include the removal of multiple sharp FBs such as nails, screws, razor blades, etc. Short overtubes (20-25 cm) are typically employed in severe FI cases (achalasia, esophageal strictures, combined meat/bone ingestions) where piecemeal removal via the mouth is warranted.

Endoscopic Success Rates

Among FBs that do not pass spontaneously, flexible endoscopic removal remains the gold standard for FB removal with a >95% overall success rate.[15-20,71] Endoscopic success rate and risk factors for endoscopic failure have been evaluated in prior studies. One European tertiary center evaluated risk factors associated with endoscopic failure. Endoscopic failure was seen in 8% of cases and was associated with advanced age, bone FB, disk battery, intentional ingestion, razor blade, prisoner population, and location of FB in the stomach. Multivariate logistic regression revealed that intentional ingestion was associated with endoscopic failure (odds ratio: 7.31; 95% confidence interval = 2.06-25.99; P = 0.002).[21]

While successful removal of FBs is frequently achieved, AEs can occur upon removal. A multicenter retrospective study showed that FB removal success rate exceeded 97%, however AEs occurred in nearly 27% of patients.[18] Significant AEs included deep lacerations with minor bleeding (16%), ulcer (5.7%), perforation (1.5%), and

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abscess (0.5%). Four cases required surgical intervention due to incomplete FB extraction. Risk factors associated with AEs included FB sharpness and greater than 12-hour duration of impaction.[18]

CONCLUSION

FBI continues to be a prevalent condition encountered by gastroenterologists. The rate of FBI has increased in United States adult population. The incidence rate of FBI has nearly doubled (3 to 5.3 per 100,000 persons) in recent decades.[71] Due to the increased incidence of FBI, it could be expected that the financial burden and frequency of endoscopic procedures will continue to rise. The advent of novel FBs and endoscopic devices utilized to remove them are continuing to evolve. Thus, knowledge of the resources and devices that are available in a particular center is critical for effective management. More than ever, it is vital that gastroenterologists have a framework for addressing FBI with respect to pre-procedural risk assessment, appropriate device selection, proper timing of endoscopic evaluation, and approach to multidisciplinary coordination. ■

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Answers to this month's crossword puzzle:

1 R	O	2 T	A	3 V	I	4 R	U	5 S	■	6 S	T	7 I	N	8 G
A	■	U	■	I	■	N	■	9 T	L	C	■	N	■	U
10 D	Y	S	P	E	P	S	I	A	■	11 I	T	C	H	Y
I	■	S	■	■	■	■	■	I	■	S	■	R	■	■
12 O	G	I	13 L	14 V	I	15 E	■	16 N	I	S	S	E	N	■
P	■	17 V	I	A	■	Y	■	■	■	O	■	A	■	18 B
19 A	G	E	■	20 C	L	E	21 A	22 R	23 E	R	■	24 S	P	A
Q	■	■	■	U	■	■	25 D	E	G	S	■	E	■	S
26 U	N	27 B	L	O	C	28 K	E	D	■	■	29 T	S	P	S
E	■	A	■	L	■	I	■	■	30 E	31 C	O	■	■	I
■	32 I	N	J	E	33 C	T	E	34 D	■	O	■	35 S	U	N
36 I	B	D	■	■	E	■	■	R	■	C	■	E	■	I
■	37 S	I	38 G	39 M	O	40 I	D	O	S	C	O	P	41 Y	■
■	■	42 N	E	D	■	I	■	W	■	Y	■	43 T	A	44 P
45 D	I	G	E	S	T	I	O	N	■	46 X	R	A	Y	S