

Review Article

Oral ingestion of foreign body in neonates and infants: a clinical review

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ABSTRACT

Foreign body (FB) ingestion in adult and children population is not uncommon but accidental. Same is rare in neonates and infants. Many of the FBs ingestion go unnoticed or unexpressed if baby is preverbal. Most of the foreign bodies pass spontaneously per anal. Only the larger size or sharp FBs get stuck in places of gastro intestinal tract and presents the patient in emergency department. Similarly corrosive and toxic FBs also invite immediate attention. Literature on the clinical aspects of the foreign body ingestion among neonates and infants was searched electronically through PubMed and individual study. Relevant articles were reviewed thoroughly and summarized. Instances of foreign body ingestion (FBI) in neonate and adult are in ascending trend over last several years. Imaging and identification of radiolucent FBs become challenging for surgeons. Conservative treatment for spontaneous evacuation, endoscopic retrieval and surgical removal are the modalities for FBI management.

Keywords: Foreign body, Neonates, Infants, Oral ingestion

INTRODUCTION

Children like to explore almost everything by putting into their mouth, hence ingestion of foreign body is often reported in children. Many of the FBs are ingested and passed out unnoticed. Over eighty percent of the ingested FB is reported in young children including neonates and infants.¹ A great chunk of known ingested FBs is passed per-anal asymptotically and only 10-20% FBs stuck in GI tract. Most of them need endoscopic interventions for their retrieval. Hardly 1-2% require the laparotomy removal.^{2,3} Based on shape FBs are classified as round-blunt or elongated sharp bodies. Radiolucent and radioopaque are the categories of FBs in the context of imaging and radiodensity.^{4,6} Most common ingested FBs in infant and young children are button battery, small toys, coins, jewelry, nail, screw, pin, beads, plastics and stone pieces.^{7,8} Esophagus is the narrowest part of the GI tract. Particularly thoracic inlet, aortic arch constriction,

gastroesophageal junction. Relatively bigger size FBs or sharpened edge FBs are generally trapped in esophagus.^{8,9} Infants with anatomical disorders in esophagus like fistula and stenosing lesions may develop challenging complication with FBI.^{10,11} 'U' curved of duodenum and coiled small bowel are also the sites for the sharp and elongated FB impaction.¹² Severe impinge or impaction of FBs may lead to morbidity, mortality or severe damage to the air-way or gastro intestinal tracts. Incidences of FBs and health hazard substances ingestion among young children are being reported in ascending trend. This draws the attention of surgeon and health carer those who look forward for novel standardized treatment approach to reduce and overcome the serious complication.^{7,13} Treatment for causative lesion of the corrosive FBI indicate conservative management to mild injuries and patients with severe injuries may endure for surgical exploration.¹⁴ Several reviews of such incidents and post incident management are available in the subject. Imaging,

endoscopy and other befitting retrieval techniques and laparotomy interventions are the standard sequential procedures to locate, identify and manage the FBs. Advent of radio imaging and fiber optic endoscopic evaluation assure quick relief and healing for preverbal neonates and infants.^{15,16} There are many novel techniques and technology available to locate, diagnose, remove, treat and manage the FBI crisis. The present review will discuss the epidemiology, modern approaches for classification, pathology and anatomical consideration, clinical manifestation, rationale of imaging, retrieval devices, treatment and management of ingested FBs in neonates and infants.

METHODS

The literatures on foreign body ingestion in neonates and infant was searched electronically through PubMed, individual study of cross references and related textbooks. Various keywords and their combinations were used for electronic literature search like foreign body ingestion (FBI), neonates, infants, radio imaging of FBs, radiodensity of FBs, endoscopic retrieval of FBs, management and treatment of FBI etc.

Criteria included in this review are epidemiology, FBs detection, diagnosis, pathology, retrieval, treatment and management in neonates and infants. Mostly review works cohort studies and case reports of the last 10 years were included in the present study.

Search resulted 62 related publications amongst which 50 were incorporated in this clinical review.

Epidemiology

The challenging clinical scenarios of FBI in neonates to young children group has been increasing consistently over the years, whereas the morbidity and mortality has been reduced considerably due to the application of modern radiographical evaluation, novel endoscopic interventions and quick presentation of patient in emergency department.^{5,6} In a retrospective study in US Emergency Department the annual increase of FBIs in children below 6 years increased 91.5% over 10 years (2005-2015) including 21.3% in the age group below 1 year.¹⁷ However, mostly the incidences are recorded more in he-children than she. Current pandemic crisis contributed several obvious reasons to shoot-up FBI cases.¹⁸ As reported a remarkable higher rate of potentially fatal FBIs patients have been admitted to pediatric emergency departments during COVID-19 pandemic especially second pandemic period (2020-21) in different countries across the world.^{19,20}

Types of foreign bodies

For all the practical purposes FBs can be classified as organic and inorganic, soft and hard, metallic and non-metallic, blunt-smooth and sharp-elongated, corrosive and non-corrosive, radiolucent and radio-opaque.^{2,7} The positive predictive value of some of the FBs are given as 100% (metallic object other than aluminum foil) 43% (crystal glass), 26% (fish bone) 0% (wood pieces).⁵ Among all the above categories morbidity rate is much higher in case of sharp-elongated and corrosive FBs. Some of the common ingested FBs by neonates, infants and young children and their categories are as given bellow (Table 1).

Table 1: Types of foreign bodies orally ingested by neonates and infants.

Types	Name	Risk factors and management
Metallic	Coin, magnet, metallic ball jewellery, button battery,	May obstruct the aerodigestive system, oesophagus, pylorus based on their size. Many of them pass asymptomatic except multiple magnets and dead battery. They need endoscopic retrieval intervention.
Non-metallic	Plastic, food bolus Stone, seed, rubber, buttons, wood piece, glass piece	May obstruct anywhere in GI tract, organic FBs are comparatively less risky if not in oropharynx. Stone rubber, plastic and wood need retrieval intervention if stuck.
Sharp and elongate	Nail, screw, pins, needle, safety pin, hair pin, hair clip, tooth pick, Razor, glass piece, Fish bone,	There is every chance of impaction and perforation in any part pf GI tract mostly upper GI tract. It is a medical emergency need imaging, retrieval/laparotomy
Corrosive	Live battery, soap, domestic chemicals, cleanser thermometer mercury,	Acute burn, perforation, tissue inflammation, tissue liquefactive necrosis vascular thrombosis, coagulative necrosis
Radiopaque	Metallic objects, crystal glass, stone seed, rubber	It is easy to locate and assess by X-ray imaging
Radiolucent	Wood, thin fine glass, plastic, Superabsorbent polymers, aluminium pop tab	Non visible by radiograph, barium application is contraindicated in perforated patient. Must be evaluated endoscopically, CT, MRI, USG
Intermediate lucency	Foodstuff, fishbone, fine thin glass	Poorly visible or non-visible in radio imaging. Must be confirmed by ultrasonography/ MRI

Pathology and vulnerable site for FB obstruction

The foremost common complication of FB ingestion in infant is partial or total obstruction of airway and food pipe. The lodged FB may lead to high-risk retention, pressure necrosis, perforation and migration across the organs. Along the GI tracts, there are several susceptible sites for FBs impediment, impaction or perforation. Vulnerable areas, in this context are described as the narrower or curved anatomical structures. Upper esophageal sphincter (cricopharyngeus), aortic crossover (mid esophagus), lower esophageal sphincter, pylorus, duodenal curve, jejunum, ileocecal valve, cecum, recto sigmoid colon etc. are the common site of FB stuck.⁹

Clinical manifestation of FBs ingestion

Many FBs are innocuous and can pass through the GI tract without any squeal, are referred as asymptomatic. Symptoms arise when the grievous FBs are lodged or impacted with trivial and fatal complications. Neonates and infants with smaller anatomy show the signs for esophageal

FBs impaction or abrasion as emesis, gagging, blood stain saliva, hypersialorrhea/ptyalism, drooling, breathless and feeding refusal. In addition, young children express the symptoms as pricking sensation, dysphagia, odynophagia, retrosternal pain.

Neck crepitus, edematous neck and pneumomediastinum, change in voice are some of the symptoms for perforated esophagus. Traumatic epiglottitis may also be a sign of FB ingestion. Hematemesis, abdominal pain, abdominal guarding, tenderness and rebound tenderness are some of the expressions given for FBs impaction in stomach, duodenum, jejunum, ileocecal valve or elsewhere in the system. As neonates and infants are preverbal babies, only clinical manifestations and evidential history help to diagnose and treat FBI.^{5,6} Solid or liquid corrosive agents starts its clinical manifestation soon after ingestion and cause acute burn, perforation, tissue inflammation, tissue liquefactive necrosis, vascular thrombosis, coagulative necrosis.^{3,7} Some of the clinical manifestations and symptoms of evident and non-evident FBI ingestion are given below (Table 2).

Table 2: Symptoms of oral ingested FB in preverbal babies.

Location	Symptom	Complicacy
Oro-pharyngeal	Blood stain saliva, drooling hypersialorrhoea/ptyalism, pooling secretions, coughing/choking, grunting, stridor, respiratory distress, tachypnea/dyspnea cyanotic episode	Scratches/lacerations/perforation. Retro-pharyngeal abscess, soft-tissue abscess/infection
Esophageal	Dysphagia/odynophagia, gagging/ vomiting, wheezing, food refusal/poor feeding	Lacerations/abrasion of mucosa oesophageal necrosis retropharyngeal abscess oesophageal obstruction/subsequent paraoesophageal abscess mediastinitis, organ perforation, extraluminal migration, penetration to heart and lungs, tracheoesophageal/aorto-esophageal fistula
Abdominal	Gastrointestinal bleeding, melena vomiting/regurgitation/gastroesophageal reflux, hematemesis/hematochezia/bilious emesis, distention of stomach and bowel obstruction	Entrapment of object within Meckel's diverticulum, penetration to liver and left lungs, perforation leads to peritonitis and advanced sepsis, acute or sub-acute bowel obstruction

Diagnosis and localization

Clinical examination based on witness statement, radiological investigation (neck chest and abdomen X-ray), endoscopic findings. 3D CT for radiolucent and MRI for nonmetallic FBs are the tools to diagnose and locate FBs. Biplane (posterior-anterior and lateral) X-ray from pharynx to rectum may be enough to locate and assess the radiopaque ingested FBs in infants. Clear visibility, poor visibility and invisibility of FBs in radiograph depends not only on the radiopacity but also on surrounding, overlaying and underlying anatomic structure.^{14,21} Therefore, the radiographic visibility of a FB may differ in different anatomic location. The lead glass or crystal glass (refractive index $n=1.7$ or more) are more radiopaque on

radiograph than the normal glass (refractive index $n=1.5$). So almost all glass FBs are radio radiopaque of different degree of radiodensity.²² The radiolucent FBs such as fish and chicken bone, plastic and wood pieces, thin aluminum foil and tabs are not clearly visible in X-ray radiograph and indicate for CT and MRI imaging and ultrasonography evaluation. Water ball, hydrogel, crystal gel, jelly beads, orbeez etc. are the product of superabsorbent polymers which are radiolucent. As ingested FBs it is difficult to be located by X-ray imaging, so it indicates CT, MRI and ultra-sonography.^{14,22} Fluoroscopy can be used to evaluate the esophageal motility and dysphagia in the cases of foreign body ingestion.

Treatment approaches

FBs can be removed from pharynx and esophagus by flexible or rigid GI pediatric endoscopy. This may be done by single piece (en bloc) or by broken piece (piecemeal) approach. Magill forceps, Foley catheters and bougie dilater devices and retrieval net can also be used for tricky retrieval. Sometimes pushed down approach is helpful to pass the soft FB down to stomach. GI region specific rigid and flexible fiberoptic endoscopes are the surgeons' choice equipments.^{1,3} Several grasping devices are used for easy retrieval for a wide range of FBs. Most common forceps used are Magill forceps, rat tooth, alligator tooth or shark tooth for hard and rigid objects. Retrieval forceps of 2-5 prongs are suitable for soft object removal. Similarly different biopsy forceps can also be used to clear the soft body obstruction. Smooth round or blunt hard objects like metallic balls, coin, disc batteries, or magnets can be harvested from their stuck site with the help of Dormia baskets, Bougie dilater.²³ Alternative to endoscope a Foley catheter is the next option for smooth removal of coin, disc battery or other non-sharp FBs from esophageal site. Similarly, magnet-attached Levin tube can retrieve metallic FBs with magnetic affinity from esophagus, stomach and upper proximal duodenum in infants.²⁴ When any sharp/pointed FB is lodged in esophagus, emergency endoscopic retrieval is indicated. FBs of stomach or duodenum can be best withdrawn by flexible or rigid endoscope. Deeply impacted or obstructive FBs beyond duodenum may need laparotomy for retrieval. The European Society of Gastrointestinal Endoscopy and the European Society for Pediatric Gastroenterology Hepatology and Nutrition (ESPGHN) recommend flexible endoscopy using rat-tooth forceps, polypectomy snares, and retrieval nets as the innocuous and promising tools for the removal of FBs from GI tract of young children. The Society further emphasized to use general anesthesia for

safe retrieval of FBs, where endotracheal intubation is a part of the procedure in the infants and toddlers.^{1,24}

Infants and neonates those who ingest corrosive and caustics material must be treated in emergency department with consultation of gastroenterologists and toxicologist. As primary precaution patient should not be given chance for vomiting or vomiting maneuvers. This prevent recontact of caustics to the esophagus, pharynx and oral cavity.^{3,7}

FB retrieval management and treatment

Known evident or suspected FBI if become symptomatic, need treatment and or management. Based on the nature of FBs and its radiopacity recommended diagnosis procedure helps to locate the FB, which may prompt for interventional removal process. Magill forceps is proved enough to remove the lodged FB from oropharynx. Laryngoscopy is helpful for FBs lodged at or above the cricopharynx. FBs beyond cricopharynx are best manipulated by flexible endoscope.

One of the most important factors to choose the gastroscope is size and body weight of the neonates and infants. When baby is underweighting 5 kg only selected options are left. However, a 6 mm gastroscope with 2mm channel can house 20 mm diameter polypectomy retrieval nets, polypectomy snares or Dormia basket devices. Selected suitable small forceps can also fit in to the above system. Polypectomy snares are the appropriate device to manipulate the sharp object for easy removal. It can close the open end of the safety pins. When the sharp end is in cephalad orientation at esophagus it is wise to push into the stomach for caudal reorientation before retrieval.⁵ A common consensus of three step management of FBs for neonates and infants are given below (Table 3).

Table 3: Three step managements of FBs in neonates and infants.

Steps	Criteria and conditions	Management
Need no imaging	Asymptomatic, normal in clinical examination, no known gastrointestinal abnormalities, known history of small noncorrosive, non-heavy metal blunt FBs, passed through pharynx and esophagus	Access the oral cavity and observe the oropharynx by illumination. Wait and watch for easy per anal evacuation.
Imaging needed (no emergency)	Round, blunt, smooth metal and non-metal medium size FBs. Passed through pharynx and esophagus asymptomatic. X-ray, CT, MRI as per the radio density of the object	Assertion the inflammation, bleeding and obstruction in upper GIT if any. Follow the movement of FB with conservative treatment such as laxatives and fibrous food, confirm per anal evacuation.
Need imaging and immediate retrieval (Emergency)	Elongated sharp objects, disc battery corrosive/caustic agent, stuck at oropharynx, oesophagus, stomach, small bowel with or without symptoms	Based on radiolucency/radio opacity of FB plan for X-ray imaging /contrast CT/MRI/USG, endoscopic retrieval/ removal with Dormia baskets/laparotomy/open surgery. Emetics, muscle relaxants, and meat tenderizers are typically ineffective.

About 10% total incidences of FBI in children is attributed to neonates and infants. Out come and prognosis of FBI in these young children is fairly good with very low morbidity and mortality. Pharmacological treatment for FBI is not much recommended except some systemic manifestation associated with allergen and toxic materials. Drugs of anti-emetics, muscle relaxant and meat tenderizer are not much recommended due to their adverse effect.²⁵ Use of glucagon for the treatment of esophageal foreign body and food impaction is not essentially effective.^{26,27} Laxatives for easy evacuation may be recommended for fast moving of FBs in GI tract. Post retrieval complications if any are to be addressed meticulously.

DISCUSSION

As mentioned above, 80-90% orally ingested FBs pass through GI tract and get evacuated asymptotically. About 10-20% of FBs remain trapped in different narrow lumen such as upper oesophagus, pyloric region, ileocecal junction and rectosigmoid colon.³ These trapped FBs are mostly removed endoscopically. Aihole et al reported spontaneous evacuation of an ingested hair pin in an infant of 7 months.²⁸ Often small GI lumen of neonates, infants and toddlers retain some of the ingested FBs which lead to many pathological conditions. Amini-Ranjbar et al in a prospective study found that the instances of corrosives (disk batteries) and sharp FBs retention in infants at 37% and 31% respectively.²⁹ These FBs are stuck in sub-glottis area (7%), oesophagus (7%) stomach and intestine (86%). They added that young toddlers are more prone to oral ingestion of FBs than early infants.

Similarly in another recent study Dörterler et al recorded the child hood localisation of FBs in oropharynx (10%), oesophagus (20%) stomach and pylorus (30%) and 10% in rest of the GI tract.³ The trapped FBs in upper GI tract are mostly removed endoscopically. In neonates and infants, it is safe to retrieve the lodged FBs under general anaesthesia. A case of stone retrieval by rigid esophagoscope in a two-month-old infant was claimed under general anaesthesia by Yadab et al.³⁰ Like adults and children, neonates and infants also ingest a wide range of FBs orally.

Collins et al reported a case of coin ingestion and its spontaneous per anal evacuation in one year old infant with conservative treatment.¹² An impacted bone removal from cervical oesophagus of a 25 days old neonate by open esophagostomy is in record.³¹ Alabkary et al claimed a laparoscopically removal of a metallic FB from the terminal ileum of a young toddler.³² Lee and et al reported a rare case of lead ball ingestion by an infant and its interventional retrieval.³³ They retrieved the balls by laparoscopic appendectomy.

Wu et al reported three cases of FBs (melon seed, dates seed and magnet) lodgment in the terminal ileum and their surgical removal in three infants.³³ They took the conservative therapy of air enema to remove a pen cap on 4th day of lodgment in a 13-month infant. Lone et al located

and retrieved an impacted gold earring jewelry from upper esophagus of a two-month-old infant.³⁴ Orsagh-Yentis et al in a cohort study found the significant ascending trend of jewelry ingestion over the years.¹⁷ They added that neonates and infants accounted for 46.8% of jewelry ingestions incidences in their study. Spontaneous removal of any blunt FB from stomach through lower gastric tract depends open the pyloric diameter of the infant. Said et al in an ultrasonic measurement study reported the normal pyloric diameter of 17 weeks infant is more than 1.5 cm.³⁵ Hence, there is scope of spontaneous evacuation of smooth and blunt FB measuring less than 1.5 cm.

Srinath et al reported FBs in the esophagus of two neonates.¹⁶ One was a radiolucent plastic dropper and other was radiopaque hangout of an anklet. Both the FBs detected in esophagus by CT and X-ray imaging respectively. Objects were retrieved by video-flexible endoscope using rat tooth forceps under sedation. Ishak et al detected a piece of phone screen protector, suspended at the vallecular region of an eight-month infant.³⁶ The FB as a radiolucent object could not be tressed by X-ray imaging. It was removed using forceps via direct laryngoscopy under general anesthesia. Quick retrieval of sharp FBs is indicated in infants to overcome oesophageal ulceration, perforation, tracheal fistula, and aorto-oesophageal fistula which may prove fatal.² It is wise to remove the sharp objects before it moves beyond the duodenal curve.²¹ Kamran et al reported that a metallic spring passed through ileocecal junction and got struck in lateral wall of cecum causing erosion and perforation in a neonate.³⁷ The FB was retrieved by proximal ileostomy. Gatto et al located two metallic nails of 4 cm (approximate) at duodenojejunal flexure of a toddler and a non-operative expectant management was followed for evacuation.³⁸

Disc battery ingestion is a rare occurrence in neonates and infants. Battery mostly contains corrosive chemicals like hydroxide of sodium or potassium, oxides of silver or mercury and heavy metals like zinc or lithium. Initial tissue injury may be caused by electrical current, electrolyte spillage. It may also lead to pressure necrosis if stuck for more time. If battery is retained and broken in GI tract it may lead to heavy metal poisoning. An oesophageal lodged button battery must be removed within 2 hours to overcome the hydroxide action on mucosa and caustic injury manifestation.² Kramer et al cross referred some fatal cases of aortoesophageal fistula due to prolong impaction of button battery in oesophagus in infants.⁵ Among all the button batteries lithium batteries are more corrosive and leads to fatal complications.²⁷ Generally, button battery looks like metallic coin on radiograph but BBs' lateral view radiograph shows two peripheral concentric rings or "step off" sign as an identified mark.⁵ Singh et al could locate an impact metallic disc battery in the upper esophagus and retrieved by esophagoscopy in a neonate.³⁹ Pizzol et al reported dramatic increase in button batteries ingestion in children including infants during COVID-19 pandemic.²⁰ This they attributed for enhanced playing activity with electronic toy and gazettes during the

pandemic period. Varga et al in their review reported button battery ingestion in a four month baby and described the harmful effect of lithium and mercury metal batteries.⁴⁰

Once a blunt FB pass beyond the esophagus hopefully it traverses the GI tract without any complication. But it is not true in case of superabsorbent polymer objects.¹¹ Bradford et al presented a case study of an infant where a radiolucent smooth spherical object could traverse through esophagus, pylorus but stuck in jejunal lumen, caused serious clinical manifestation and indicated enterotomy.²¹ Hydrated superabsorbent polymer balls can increase 30-60 times of their dry volume but they are radiolucent, invisible on radiograph.^{5,41,42} These balls can be retrieved by retrieval net or wire basket or polyp snare as per the shape or size of the FB. Mirza et al reported a case of crystal gel balls ingestion in a six-month-old infant.⁴³ Swollen crystal gel was removed by enterotomy but patient succumbed due to anastomotic leak. Patcharu et al reported a case of radiolucent raisin obstruction of small bowel in 2 days old neonate.⁴⁴ They remove it by enterotomy.

Ingestion of caustic substances are often seen in infant below three years age and instances are more in male child. Strong alkaline substances as FB (pH>11.5) are more detrimental as that quickly promote the saponification and liquification necrosis. Oral ingested of caustic substances is observed to produce lesions in digestive, respiratory, and ENT tracts. Common sequelae are stricture formation in esophagus, stomach, pylorus, duodenum and small bowel, perforation along the GI tract, and hemorrhage. Retrosternal pain, gastro-esophageal reflux and melena are some of the common clinical manifestations seen in neonates and infants.^{3,45}

Accidental oral ingestion of sulphuric acid (strong acid) in a 6-hour neonate and drain opener (a strong alkaline) in an infant were reported from medical emergency departments.^{46,47} Strictures developed in GI tract due to ingestion bleach, lipid dissolver, limescale dissolver and hydrochloric acid are often reported in children under one year.⁴⁸⁻⁵⁰

CONCLUSION

Neonates and infants are of small and delicate GI structures. They also cannot express their feelings and pain in words. Types of FBs, their shape and size, corrosiveness, site of lodgment (if any), and expected complications can indicate the proper retrieval method or conservative treatment. The retrieval of FBs always requires appropriate paediatric endoscopic equipment.

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