Part 1

Airway

Part 2

Gastrointestinal tract

Esophagus, stomach, intestine

Foreign bodies

Samuel Negash M.D.

Pediatric Surgery Resident

Addis Ababa University

Part 3

Ear & Nose

Part 4

Urogenital

1. Airway FB

Epidemiology

- More common in **males** (2x)
- More common in **Toddlers** (80% are < 3 years)
- More common in **Right main bronchus** (equal predilection in younger)
- More commonly **food items** (seeds/nuts)

Predisposition of toddlers

- **Inquisitive** – exploring on the ground
- **Oral stage developmentally**– put everything in their mouth
- **Lack dentition** – unable to grind food
- **Not attentive to eating** - Inhalation/laughter at the wrong time
- **Immature swallowing mechanism and airway protection** – likely to choke
- **Narrow airways** - can get lodged anywhere

Common Objects

Organic

- Nuts & Seeds
  - Peanut
  - Maize/corn kernels (በቆሎ)
  - Bean (ባቄላ)
  - Kidney bean (ቦሎቄ)
  - Coffee bean
  - Pea (አተር)
  - Chick pea (ሽምብራ)
  - Guava (ዘይቱን)
- Bones
- Egg shell (larynx)

Non organic

- Coins
- Balloons
- Buttons
- Toys
- Marbles
- Beverage tops
- Pins & hair clips
- Screws & nails

Mechanism

- Children can't macerate nuts into smaller pieces
- Seeds swell in the airway and obstruction progress
- **Lipophilic (peanuts)** – chemo-inflammatory response in 24 hrs
    - **Mucosal edema** and **Granulation tissue** within a few days (difficult extraction)

Types of bronchial obstruction

- Complete Obstruction of larynx/trachea is rapidly fatal
- Majority lodge in primary or secondary bronchus
  - Bypass valve - Air pass in and out (normal)
  - Check valve - Exhalation prevented (hyperinflation)
  - Stop valve - Both inhalation and expiration blocked (atelectasis)

Symptoms

- Most chocking events are **witnessed** – coughing/chocking with swallowing
- **No symptoms** – 40%
- **Classic triad** – 40% - cough, wheeze, dyspnea (Sudden onset, no prior fever)
- Other symptoms
  - Stridor (inspiratory for laryngeal pathology, expiratory for tracheal FB)
  - change in voice/cry
  - decreased sounds, Desaturation, retraction
  - Chest pain, bleeding

DDx

- Infection
  - Croup/epiglotitis
  - Retro-pharengeal abscess
- Tumor
- other

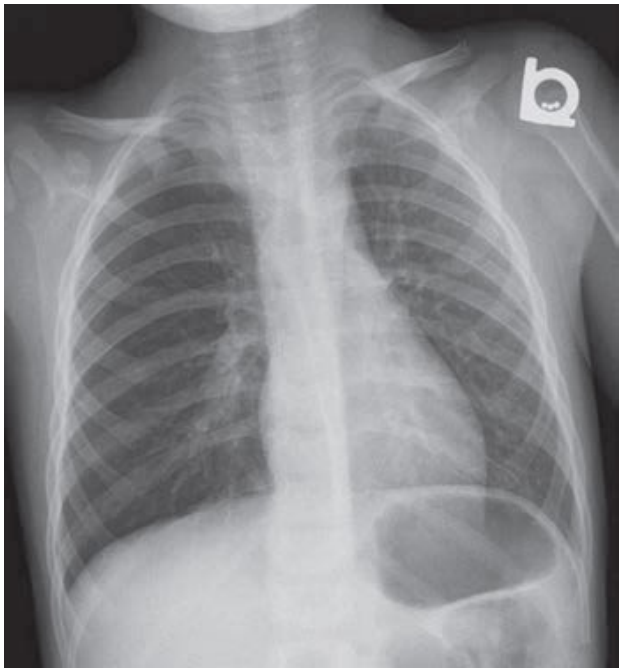
Emergency treatment

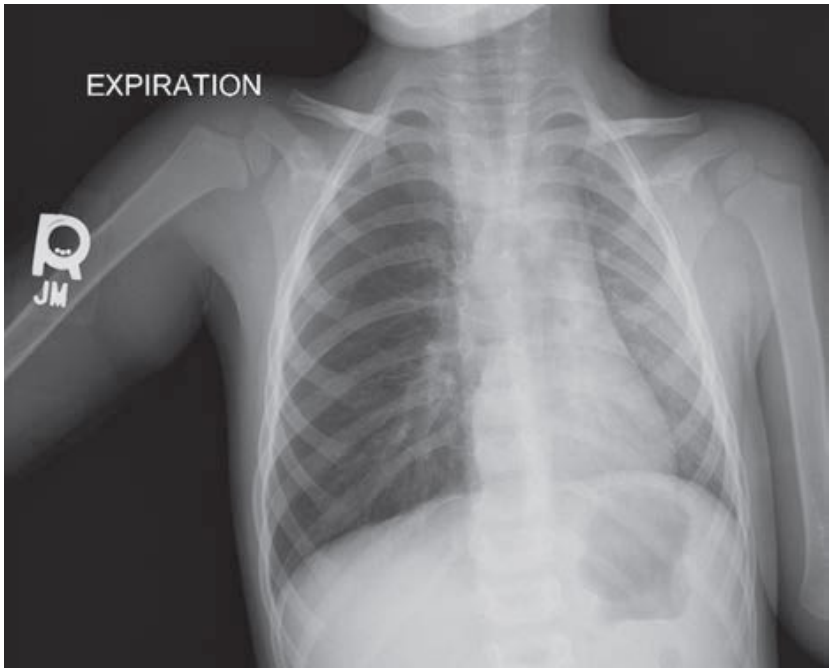
Don't apply if the patient can speak/cough– encourage cough

- **5 Back blow- 5 Chest thrust** (infants)
- **Heimlich** (older child)- risk of injury to abdominal viscera
- **Finger sweep/grasp-** if visible and will not be wedged deeper
- If fail **mouth-to-mouth resuscitation**
- **Basic resuscitation** should be continued with 100% oxygen using BMV

Chest x-ray

- AP and lateral, neck and chest
- Chest findings
  - Hyperinflation/air trapping (60%)
  - Normal (20-30%)
  - Radiopaque FB (6-20%)
  - Atelectasis
  - Pneumonia





- **Expiratory film enhances yield** - Hyper expansion of the lung more noted on expiratory film

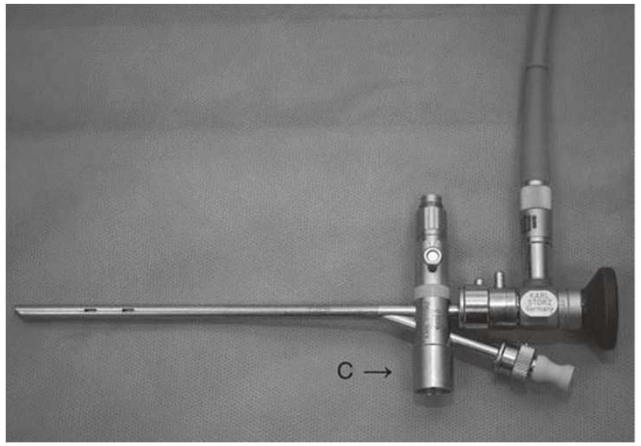
Management

- **Flexible bronchoscope:** For diagnosis in unreliable history
    - Negative bronchoscopy of 10-15% is acceptable.
- **Rigid Bronchoscopy** – 99% success rate.

- **Flexible scope:** remains an option for diagnosis. Most newborns can breathe normally around this scope for a period of time. Ultrathin (noodle scope) can be inserted in ETT but these scopes have limited working channels. Failure to retrieve a foreign body by flexible bronchoscopy necessitates rigid bronchoscopy, and facilities must be available to proceed with this under the same anesthetic.

Table 4.1 Storz bronchoscope sizes relative to the child's age and airway diameter

		Preterm–1 month	1–6 months	6–18 months	18–36 months	3–6 years	6–9 years	9–12 years	12–14 years
Cricoid (AP diameter)	ID (mm)	3.6–4.8	4.8–5.8	5.8–6.5	6.5–7.4	7.4–8.2	8.2–9.0	9.0–10.7	10.7
Endotracheal tube size	ID (mm)	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
Bronchoscope size (Storz)	Size	2.5	3.0	3.5	4.0	4.5	5.0	6.0	6.0
	ID (mm)	3.5	4.3	5.0	6.0	6.6	7.1	7.5	7.5
	OD (mm)	4.2	5.0	5.7	6.7	7.3	7.8	8.2	8.2



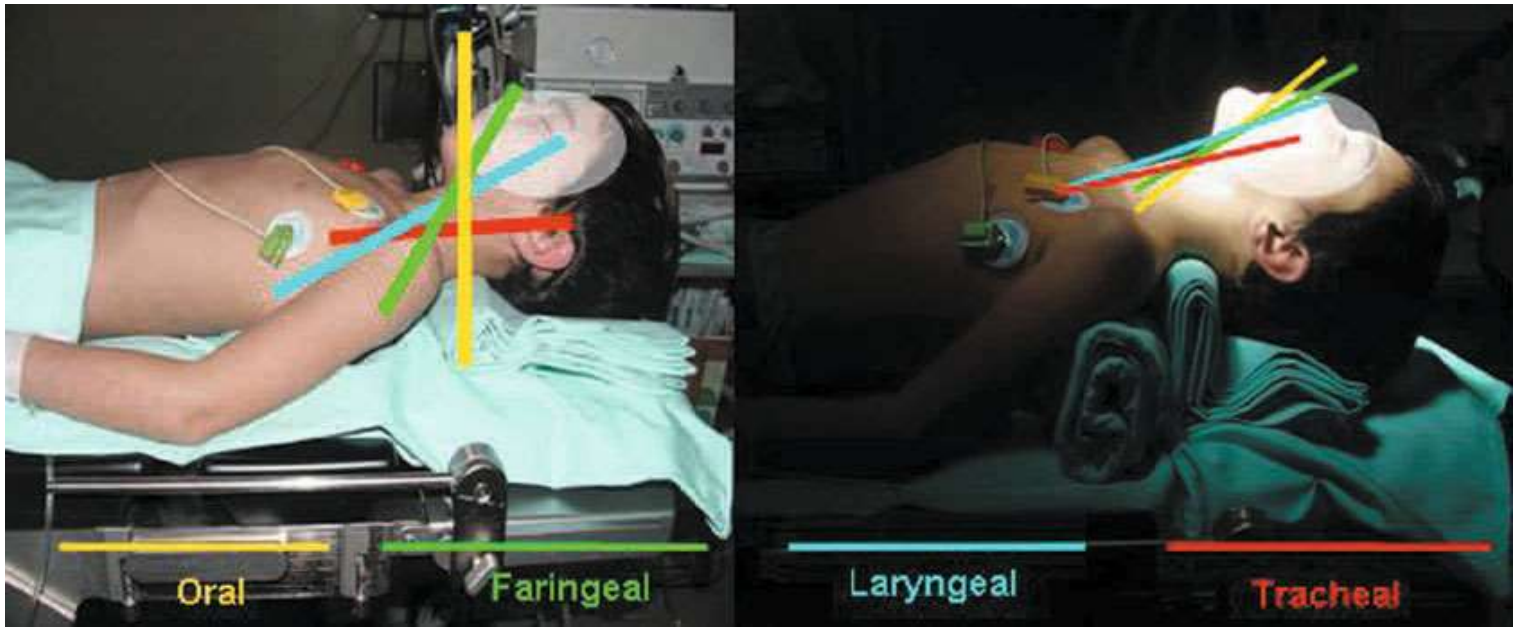
- **Rigid Bronchoscopy**: Instruments vary in size (2.5x20cm - 6x30cm). Length and diameter are determined by age and size of child. Use the **largest scope possible that will not cause trauma** (usually storz 3.5, 3.7 and 4 are used). Adequate caliber allows FB to be retracted into scope decreasing inadvertent dropping of FB. Telescopes and bronchoscopes must be **kept warm to minimize condensation**, which will fog the endoscopic view. The **surgeon and anesthetist should discuss strategy** and their relative responsibilities prior to the arrival of the child. Make sure that **all needed instruments are in working order** before child is brought to the OR. Following successful removal, **attention to proper cleaning** of instruments is important as it may predispose to cracking equipment that could lead to bacterial contamination

Anesthetic considerations

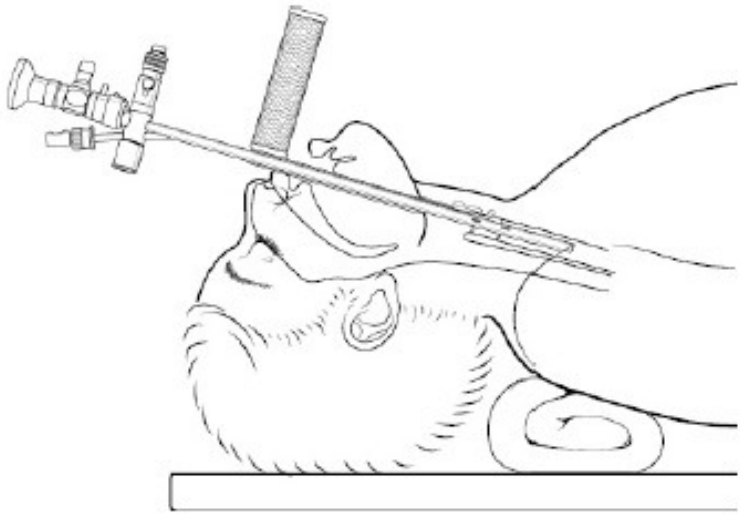
Spontaneous ventilation is preferred (avoid distal migration of FB, air trapping, pneumothorax)

- Premedication**: Atropine** (dec. secretion + mitigate effect of vagal stimulation)
- Induction: volatile agent (**sevoflurane /halothane**) in oxygen.
- Local/topical anesthetic: **Lidocaine spray** (2-4mg/kg) to glottic area (dec coughing and minimize laryngospasm.)
- Maintenance: stable plane of deep anesthesia
  - **inhaled agent** in oxygen given via the bronchoscope.
  - **Propofol** (continuous infusion or small bolus) - adjunct to inhalational / to deal rapidly with coughing .

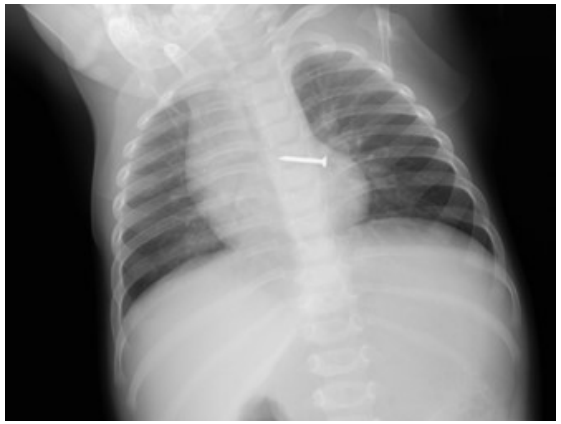
***Monitor oxygenation, HR & rhythm and BP closely.*



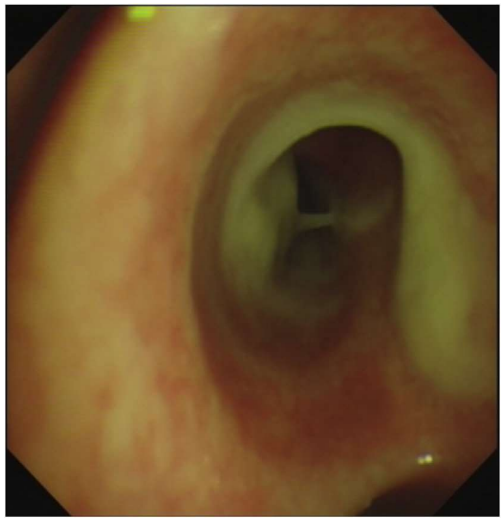
- **Positioning**: head in **“sniffing "position** with folded towel under shoulder. **Eyes are taped** and protected. **Precautions not to injure lips**, tongue and teeth. Careful **laryngoscopy** may reveal FB that can be retrieved with MaGill forceps. Once bronchoscopy starts team must be **ready for emergent intubation** or rarely tracheostomy.

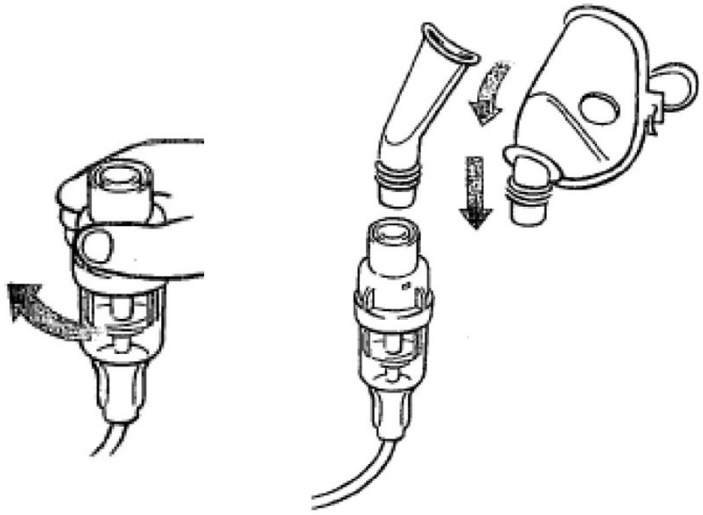


- **Intubation:** is difficult b/c larynx anterior and subglottic region is the narrowest. As **vocal cord** are approached **rotate scope 90 degress** so that its leading edge is in an anteroposterior direction. **Rotate back on entering trachea**. Diagnostic **evaluation in a systematic fashion.** Carina >> rt main bronchus (rotate head to left and angle scope to right) >> left main bronchus. **Ensure lumen of the airway remains in view at all times** to avoid pushing a foreign body further down. Dilute epinephrine 1-2ml of 1:10,000 may be instilled around FB using flexible suction catheter to dec mucosal edema.



- **Removal of FB:** Once the foreign body is located the bronchoscope is **positioned approximately 2 cm** above the obstruction and supported by the surgeon. Jaws of the forceps. are opened once they emerge from the end of the bronchoscope and the foreign body is **grasped under direct vision**. **FB and scope are withdrawn together**. In the case of **globular organic FB** it is important to use peanut forceps, ensure that the blades of the forceps pass beyond the equator of the object and grasp gently to minimize the risk of fragmentation. If the foreign body is **small FB** **that is unlikely to fragment** may be retrieved through the bronchoscope. **Sharp FB** should be retrieved either blunt end first or draw pointed end to shaft of bronchoscope so that won't injure mucosa when go out . Rarely **big/swollen FB** is too large for removal through larynx may require cervical tracheotomy than risk impacting the object in the subglottis.





- **After Removal :** It is mandatory to **examine the distal airway** after removal of a foreign body to exclude additional foreign bodies or residual fragments and to **aspirate secretions**. Postoperatively the patient is at risk of developing upper airway edema and stridor(especially with repeated passage of scope) **Patient should be observed 12-24 hrs post procedure** and **dexamethasone** is commonly given to prevent this complication. **Nebulized epinephrine** may be used to treat stridor. Increasing airway obstruction may necessitate **intubation.** The patient is at risk of aspiration until the effects of topical anesthesia to the airway have worn off, and should be kept fasted until protective reflexes have returned. If there is significant lobar collapse chest physiotherapy and antibiotics may need to be continued for a few days postoperatively.

Difficult Bronchoscopy

- **Difficulty maintaining oxygenation**
  - loose connection from ventilation port or operative side port can be the cause
  - Furthermore telescope should be removed to make scope free for ventilation. (Q 5min)
- **Difficulty reaching FB** (impacted in distal airways or upper lobe bronchus)
  - Move it to accessible location by applying suction through scope
  - Flexible scope with dormie basket/fogarty can remove
- **View obscured by bleeding**
  - bleeding granulation will resolve once FB is removed
  - instill cold NS or dilute epinephrine
  - abandon procedure if difficult
- **Failed retrieval (edema)**
  - abandon procedure and attempt after 24–72hrs
  - Optimize with inhaled epinephrein and IV steroid before second endoscopy.
  - thoracotomy with bronchotomy/lobectomy may be required (<1%),

Difficult Bronchoscopy

- **FB lost during retrieval**
  - FB in trachea & easy to grasp - retrieve
  - FB in trachea & Difficult to grasp - Push it back to & make second attempt to retrieve
  - FB not seen
    - Withdraw scope inspecting larynx & hypopharynx
    - Endotracheal Intubation
    - Examine mouth, nose and esophagus

Retained FB

late presenting / neglected FB

- **Symptoms**
  - chronic cough
  - History of FB aspiration in 50% .
  - Recurrent lobar pneumonia, bronchiectasis, broncho-esophageal fistula

- **Type of FB**
  - Inert - may remain embedded without causing significant symptoms
  - Organic - induce reactive granulations and secondary bacterial infection.

- **Bronchoscopy** – with great care in planned manner
  - Bleeding from granulation tissue
  - Bronchial stricture

Complications

- Dental injury (protect with fingers and gauze)
- Hypoxia
- Laryngospasm (dec with good anesthetic, minimal mucosal contact, ensuring no active bleeding when finish)
- Post-obstruction pulmonary edema
- Bleeding (granulation tissue, mucosal injury)
- Pneumothorax
- **Persistent lobar collapse** may require repeat bronchoscopy after intensive medical treatment.
  - Residual foreign body
  - Bronchial stenosis
  - Bronchiectasis (may require lobectomy)

Prevention

- **FBA legislation**: Regulate production, labeling, distribution of toys for children under 3 (testing using a “small parts cylinder”)
- ? Food safety, Spherical objects, Latex balloons

2.1. Esophageal FB

Epidemiology

- Most occur b/n 6mo-3yr
- Most pass spontaneously
- 10-20% require endoscopy
- <1% require surgery

Sites of impaction

- Physiologic Esophageal narrowing
  - **Cricopharyngeus (70%)**
  - Aortic arch/ (15%)
  - GEJ (15%)
- Pathologic narrowing (<10% children/ 80% of adults)
  - Esophageal webs
  - Stricture
  - Motility disorders
  - Developmental/psychiatric

Objects

- **Coins** : most common
- Other
  - Toys, pencils, erasers
  - batteries
  - needles, straight pins, safety pins screws, earrings, glass
  - fish and chicken bones, meat

Pathophysiology

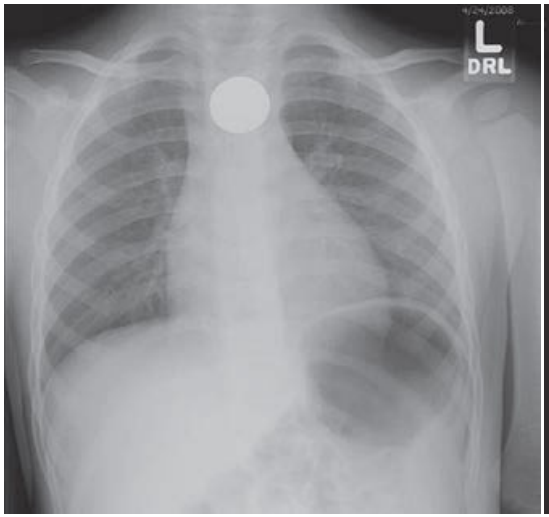
- Luminal obstruction (Risk of aspiration)
- Airway compression
- Mucosal injury (bleeding, necrosis)
    - Perforation
    - Stricture
    - TEF
    - AEF (suspected if have episodic minor hematemesis)

Presentation

- witnessed event or disappearance of an object.
- **Refusal to eat**/dysphagia, Odynophagia
- **Chest/neck pain** (may point to level of obstruction)
- **Drooling/spitting**, regurgitation ,chocking, Vomiting
- **Resp. symptoms** (Stridor, chocking, gagging, coughing)
- Physical – signs of comp (crepitus, signs of peritonitis)

Workup

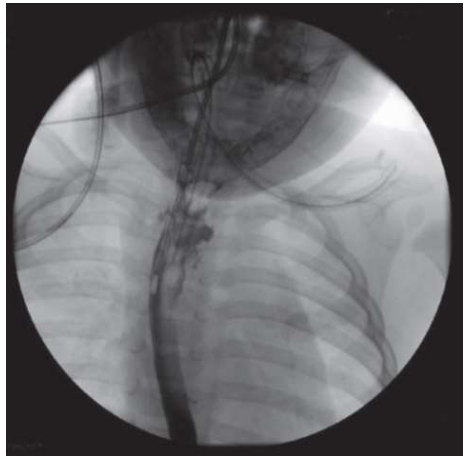
- Neck-chest –abdomen x-ray
    - **65% are radiopaque-** exceptions are wood, plastic, glass and bones
- AP & lateral view
    - Stacked objects
    - Coin from battery
    - Esophagus vs trachea





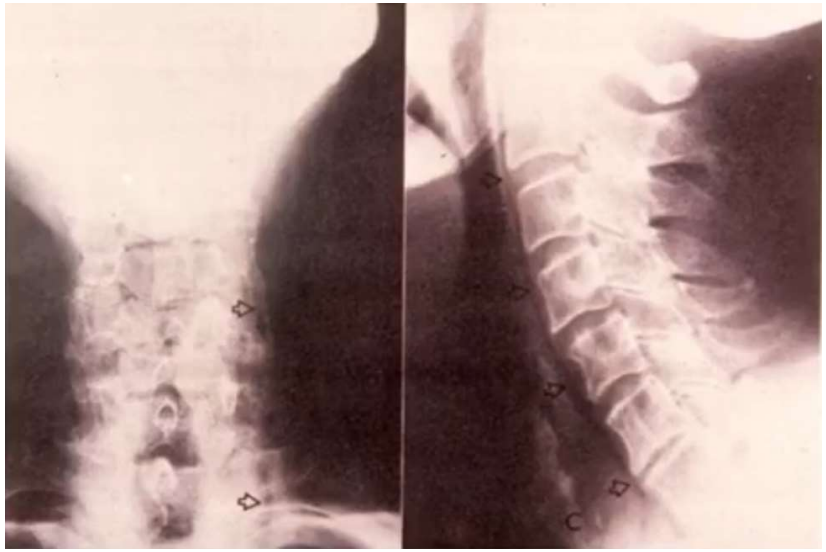
- **Coin**: Coins lodge in frontal (coronal) plane in esophagus (sagittal if in trachea). Lateral view may show superimposed coins. **Oblique orientation may indicate wall erosion** and is an indication for CT if coupled with long history. Completion esophagoscopy is recommended following removal (may be more than one). An asymptomatic child, with known time of ingestion can be observed for 24hrs. (20-30%will go down to stomach spontaneously)



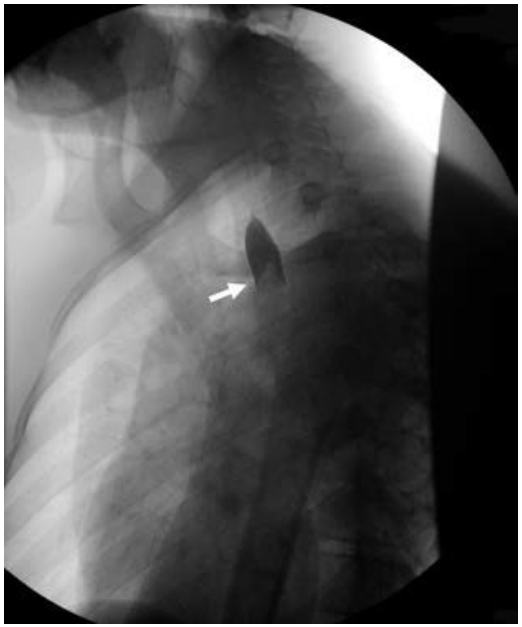



- **Button battery**: button batteries resemble coin on x ray but have double contour rim (**halo sign**) on close inspection. Can cause injury even if dead battery (electrical charge when react with saliva). Hydrolyzes water and generate hydroxide creating **Alkaline caustic injury**. Can also cause problems through leakage of material (mercury, silver, lithium) begins within 15 minutes and **perforation can occur in 8hrs**. Injury may **continue even after removal**. Intra-op esophagogram may show mucosal irregularity/perforation which necessitate tube feeding.

- **Fishbone**: 20-35% of dysphagia after eating fish have fish bone. Only 33-50% are visible on x ray. Most are in posterior pharynx (retrievable with magill). Calcified arytenoid cartilage is a normal variant that can mimic fishbone



- **Sharp objects:** the most common are **straight pins, needles** and **straight paper clips.** Risk of **perforation is 15-35%. M**ay perforate the esophagus, resulting in neck swelling, crepitus, or pneumomediastinum. risk of mucosal injury during retrieval of a sharp object can be minimized by orienting the object with the sharp-end trailing during extraction. open safety pin provide special challenge. If sharp tip is directed distally then safe removal is achieved by grasping blunt apex and extracting it. If sharp tip is proximal it can be grasped or turned around so that tip points distally. FB in oropharynx are usually sharp and may complicate with retropharyngeal abscess formation. Prevertebral air maybe seen from hypopharyngeal perforation.



- **Food impaction**– rare in children. Associated with underlying esophageal disease. chest xray may be normal but esophagogram shows FB in esophagus. **pull technique-** peicmeal removal, require multiple passes of endoscope incurring inc morbidity. **Push technique** has similar success rate with minimal risk of perforation if proper technique followed. Unsuccessful attempts using one technique can be rescued with the other.

Management

- FB in lower esophagus may be observed
  - May use Bouginage/NGT to push to stomach if don't pass with observation (especially for food bolus)
- Object in upper esophagus needs removal. **Emergency if ...**
  - Airway compromise
  - Complete obstruction (cant swallow secretions)
  - Active bleeding
  - Disk/button batteries
  - Sharp objects, long (>5cm), multiple magnets
  - Object lodged for >24hr or unknown duration

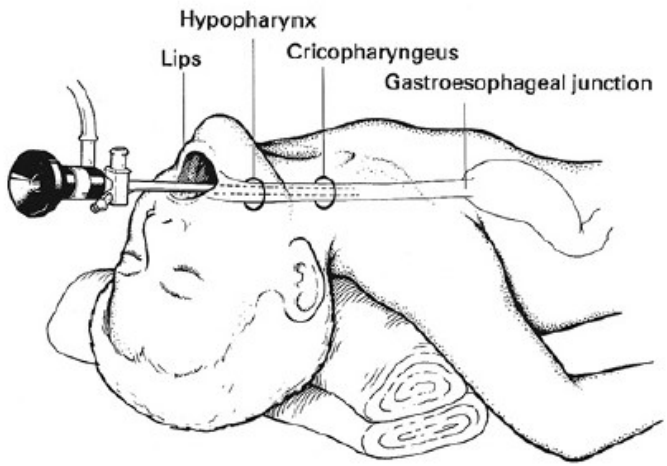
TABLE 1. Timing of endoscopic intervention in pediatric foreign body ingestions

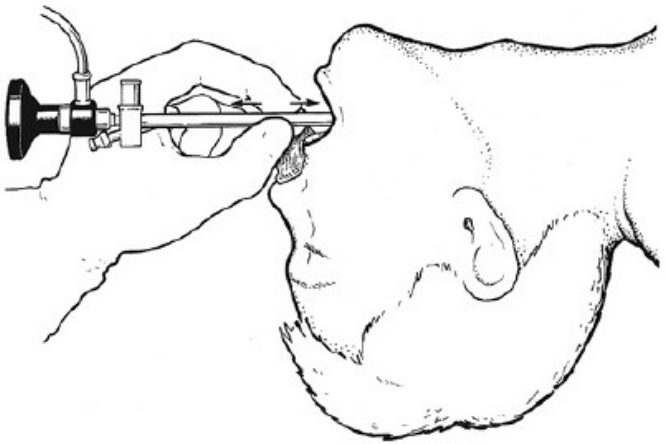
Type	Location	Symptoms	Timing
Button battery	Esophagus	Yes or No	Emergent
	Gastric/SB	Yes	Emergent
		No	Urgent (if age <5 and BB ≥20 mm)
			Elective (if not moving on serial x-ray)
Magnets	Esophagus	Yes	Emergent (if not managing secretions, otherwise urgent)
		No	Urgent
	Gastric/SB	Yes	Emergent
		No	Urgent
Sharp	Esophagus	Yes	Emergent (if not managing secretions, otherwise urgent)
		No	Urgent
	Gastric/SB	Yes	Emergent (if signs of perforation, then with surgery)
		No	Urgent
Food impaction	Esophagus	Yes	Emergent (if not managing secretions, otherwise urgent)
		No	Urgent
Coin	Esophagus	Yes	Emergent (if not managing secretions, otherwise urgent)
		No	Urgent
	Gastric/SB	Yes	Urgent
		No	Elective
Long object	Esophagus	Yes or no	Urgent
	Gastric/SB	Yes or no	Urgent
Absorptive object	Esophagus	Yes	Emergent (if not managing secretions, otherwise urgent)
		No	Urgent
	Gastric/SB	Yes or no	Urgent

- **Timing consideration -** Emergent- <2hr , urgent <24hr (follow NPO guideline), elective>24hr

Options for removal

- **Magill forceps** - Fb in oropharynx and upper esophagus
- **Rigid endoscope**– better view, more control for sharp objects, higher risk of perforation
- **Flexible endoscope** – smaller risk of iatrogenic damage
- **Foley Catheter** (Contrast media filled balloon with fluoroscopy guidance)- 80%
  - Round smooth FBs (difficult to grasp like marble)
  - impacted for < 1week
  - No evidence of complication or pathology





- **Rigid Esophagoscope**: GA with ETT is preferred. Positioned supine with roll under shoulder to make oroesophageal axis straight (sword swallower's position). Direct visualization, is facilitated by lifting the tongue and epiglottis with a laryngoscope and directly visualizing the entry into the esophagus. Scope is grasped with the supporting hand like a pencil, while the remaining fingers rest against the maxilla. Scope is then slowly advanced, cautiously feeling for resistance. If any difficulty is encountered in negotiating, a small soft catheter may be used as a lumen finder to gently advance the scope. Once the stomach has been entered, the esophagoscope is slowly withdrawn. During withdrawal of esophagoscope, best examination of both the stomach and the esophagus can be obtained .

After endoscopic removal

- **Re-insert endoscope** after removal
  - Asses damage / perforation
  - Look for pathology that may have caused esophageal narrowing
- **Observe in E.D** until sedatives wear off (at least 4 hrs)
  - Liquid diet first few hours
  - X-ray if complications are suspected
- **Admit Battery ingestion** – may have delayed damage (perforation, TEF, stricture)

Complication

- Signs of perforation
  - air in soft tissues/ mediastinum
  - Pneumothorax/pleural effusion
  - Retropharyngeal swelling
- Failed removal - Thoracotomy is required rarely for FB embedded in the wall.
- Long standing FB – weight loss, recurrent pneumonia, stricture, fistula

2.2. Stomach and intestinal FB

FB in stomach

- 90% will pass in less than a week
- only 1% require removal
    - **width** >2.5cm have difficulty passing **pylorus**
    - **length** >6cm can't pass **duodenal loop**

Observation

Outpatient follow up

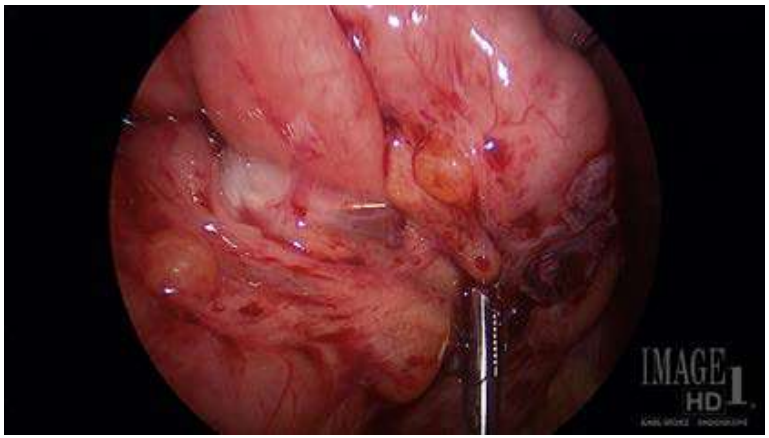
- May remain in bowel for prolonged time
- Parents may miss it in stool in 50%
- Repeat x ray can be performed at 2-3 wk interval.
- intervention deferred for 4-6 wk

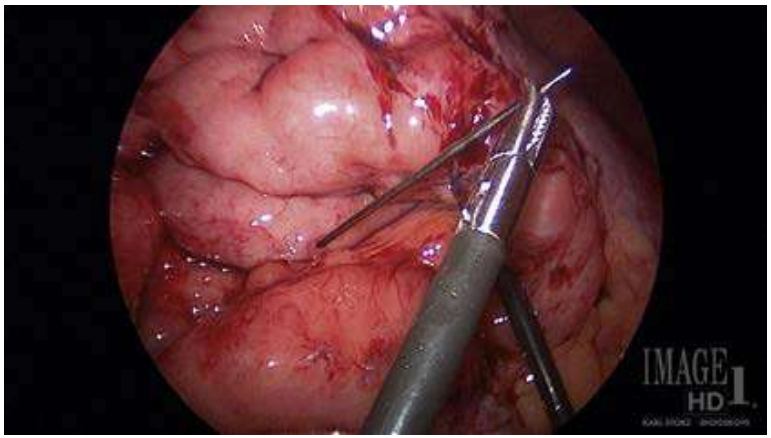
Indication for admission

- High risk object
  - Sharp
  - Length > 6.5cm
  - Cocaine packets / Potential toxin
- Multiple objects ?
- Preexisting GI disease ?

Intervention

- Endoscopy
  - Large objects
  - Sharp objects
  - Magnets
- Surgery
  - obstruction (vomiting, distention)
  - Bleeding
  - Peritonitis
  - Failure to move distally ? >2week

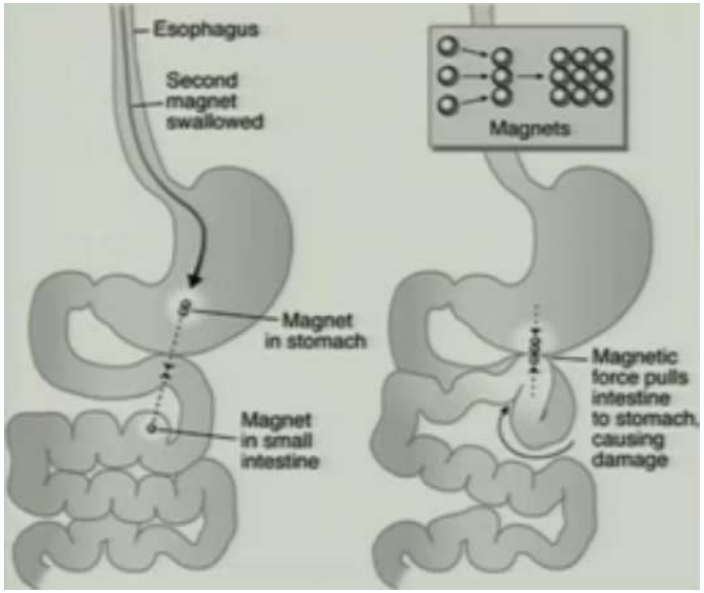


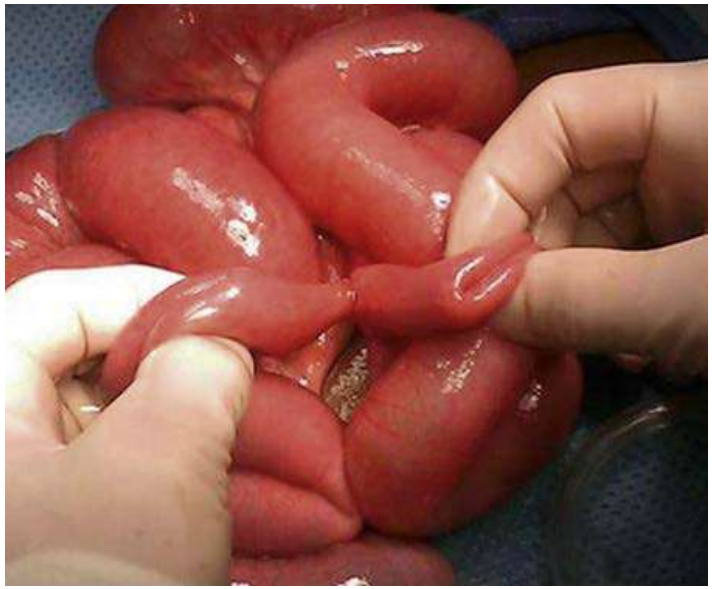


- **Sharp objects :** Larger object should be retrieved endoscopically or observed closely . smaller object & straight pins may be managed conservatively. If perforation occur, more likely at ileocecal valve.

- **Battery in stomach**: Endoscopy should be done if symptomatic or if persist in stomach for 5-7days.

  Battery in bowel should be x-rayed if not passed in 10-14d but If symptomatic observe inpatient and consider removal (laparoscopy/endoscopy)





- **Magnets –** morbidity if multiple magnets or a single magnet and second metallic FB (attract across layers of bowel). 40% are symptomatic. May lead to obstruction, volvulus, perforation or fistula through pressure necrosis. These must be **removed if in stomach**. If in **bowel** , **must be observed inpatient** even if asymptomatic. **Operate if failed to progress in 48 hr** or develop signs of obstruction

- **Bezoar**– undigested material obstruct gastric outlet/intestine. lactobezoars (milk), phytobezoars (plant), or trichobezoars (hair).

FB Types	Endoscopic Removal	Surgical Removal	Imaging Follow-up
Any FB causing symptoms of complete esophageal obstruction requires emergency endoscopic removal			
Sharp FB	Emergency endoscopic removal if it is in the esophagus Urgent endoscopic removal if in the stomach	If symptomatic and beyond the reach of endoscopy or too dangerous to remove endoscopically If failure to progress after 3 days	Daily radiograph for up to 3 days Consider CT for radiographically invisible FB or evaluation of complications (eg, abscess)
Blunt FB	Urgent endoscopic removal if it is in the esophagus or if the FB is >6 cm in length and proximal to the duodenum If the FB is >2.5 cm in width and proximal to the duodenum If the FB fails to pass through the pylorus after 3–4 wk	If immobile and distal to the duodenum for >1 wk If symptomatic and distal to the duodenum	Weekly radiograph for up to 4 wk
Coins	If asymptomatic, observe for 12–24 h before considering endoscopic removal If proven to be button batteries in esophagus on imaging, emergency removal is required	If immobile and distal to the duodenum for >1 wk	Weekly radiograph for up to 4 wk
Batteries	Emergency endoscopic removal if button battery in the esophagus If larger (>2 cm) batteries remain in the stomach >48 h	If immobile or symptomatic and beyond reach by endoscopy	Once batteries past GE junction, initial follow-up radiograph at 48 h Once past the pylorus, repeated radiograph every 3–4 days
Magnets	Urgent endoscopic removal of all magnets within endoscopic reach	If magnets appear immobile on serial radiographs and beyond the reach of endoscopy, surgical consultation is recommended[23,25,36] If symptoms of obstruction or perforation[36]	Close follow-up with frequent serial radiographs to ensure mobility

- **Summary** – follow-up and indication for intervention in ingested foreign bodies

3.1. Nasal FB

Presentation

- Bad odor
- Unilateral rhinorrhea
- Epistaxis
- sinusitis

Management

- Use decongestant for exam
- Removable with suction, alligator forceps, inflatable balloon, positive pressure method
- May require GA for removal
- May need antibiotics post removal

3.2. Ear FB

Presentation

- Insect (cockroaches) are common
- Patients have been misdiagnosed as psychiatric

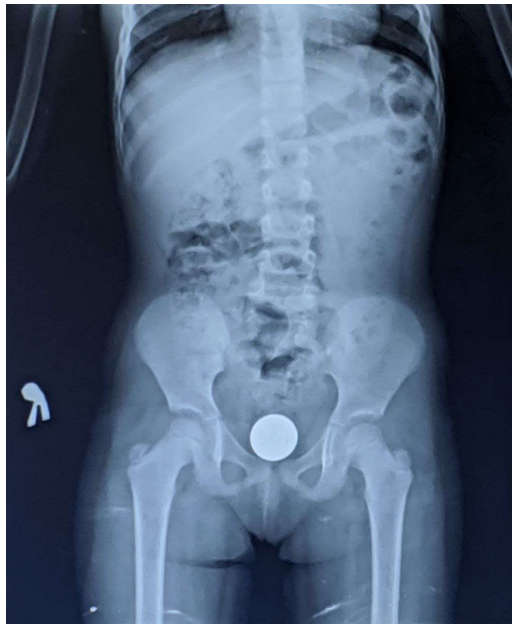
Management

- Fill ear canal with 2% to cause bug to seize & jump out
- May require GA for removal
- May need otic antibiotic drop if canal wall injured

4.1. Vaginal FB

Presentation

- prepubertal vaginal discharge
- Prepubertal bleeding in the absence of a history of trauma
- History of FB insertion
- History of sexual abuse (perpetrator inserting objects)
- Complication – infection, PID, necrosis, fistula
  - Battery - ulceration, stenosis
  - Sharp FB- migration into pelvis, bladder, GI tract



Management

- irrigation with warm saline via NGT
    - allow visualization FB in OPD (without speculum)
    - It can also flush out small bits of **toilet paper** (most common FB)
- vaginoscope under sedation If patient can't tolerate exam
    - irregularities along vaginal wall (granular reddening suggestive of a recently extruded FB)

4.2. Rectal FB

Presentation

- **Involuntary in children**– sexual assault, drug trafficking
- Anal/abdominal pain
- rectal bleeding

Management

- **Trans-anal removal** after sedation
  - Lithotomy position DRE with abdominal pressure
  - Inflate Foley beyond object and inflate balloon to assist removal
  - May also use instrument (kocher) to pull out
- **Indication for surgery**
  - Perforation/peritonitis
  - failed transanal removal
- **Sigmoidoscopy** after removal to look for mucosal injury or perforation. also see additional fb
- Comp - mucosal tear, disruption of sphincter, fecal incontinence, perforation, bleeding


The End