

Review

Anatomic Explanation for the Presence of Foreign Bodies in Natural Orifices

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Abstract: Foreign bodies are very common in the Emergency Department worldwide and expend a lot of time of medical staff to extract them. A plenty of these situations are accidental or involuntary, while others are intentional, depending on the patient's age. The anatomical location associated with the sort of foreign body determines the type of symptoms and complications resulting even as the procedure required for its extraction. The present study aims to explain, based on anatomical knowledge, the occurrence of accidents and incidents with foreign bodies in the aero-digestive tract, external auditory canal, nasal cavities, and eyes.

Keywords: Anatomy; Foreign body; Natural Orifices.

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1. Introduction

The anatomical location of the foreign body is a determining factor for the resulting symptoms and complications, as well as the procedure required for its removal [1]. In emergency services, there are a great number of patients with foreign bodies inhaled, aspirated, or introduced voluntarily or involuntarily. It affects children and adults although, in some locations, it is exclusively pediatric, such as in the nasal passages and bronchi, with exceptions for adults with mental disorders [2]. In the lower airway it is usually caused by an accident [3] and can be fatal. In other locations on the head and neck, in children, it may be intentional to get the parent's attention, teasing or bullying other children or to explore orifices by themselves.

To transport illegal substances and objects to certain destinations, prisoners, visitors, and international drug mules use their own bodies to transport stuffs. In the genitourinary tract, insertions of foreign bodies can be caused by psychiatric disorders, with self-injurious or attention-seeking behaviors and in polyembolocholomania being forms of sexual satisfaction, often resulting only in surgical extraction. Some locations are associated with pleasure and are typical of adults, such as the anal and vaginal canal [4].

In the clinical anatomy discipline taught in the 4th semester of the medicine course, students deal with clinical cases, some of them are related to the problem of foreign bodies. Therefore, we decided to study this topic to better understand and support students. Most of FBs in the ENT area (auricular, nasal, and palatine tonsil) are found on the right side because of right-handed population dominance.

The present study aims to explain, based on anatomical knowledge, the occurrence of accidents and incidents with foreign bodies in the aero-digestive tract, external auditory canal, eye, and nasal cavities.

2. Eye

The Eye is in the anterior part of the Orbital Cavity. It has an irregularly spherical shape, weighing 8 to 10 grams and has a firm consistency. Each eyeball is made up of 3 layers: outer fibrous: sclera (white of the eye), intermediate vascular pigmented (muscle-vascular): uvea and inner nervous: retina and four media of transparency: Cornea, Aqueous humor, Crystalline and Vitreous humor. The main ocular region minded receiving trauma by foreign bodies are the corneas, being usually clinically treatable [5]. On average, 8% of cases arrive at the hospital emergency department [6]. Workers are the most affected on labor time [7].

In most cases, there is no loss of vision in patients and foreign bodies are rarely dangerous in the region [8]. Adults can be affected by the result of automobile accidents that can outcome in broken glass, physical fights, falls, strands of hair, eyelashes [9] and dust particles [5]. However, children for being high-energy may suffer from foreign bodies and 27% of admitted cases require hospitalization [10]. In a study carried out in Antalya it was possible to observe that Superficial corneal foreign body were the most prevalent in the eye (72.6%) [11]. Globally the number of incident cases of Intraocular FBs increased by 30.29%, from 35.79 million in 1990 to 46.63 million in 2019 [12].

3. External auditory channel

The external auditory canal is divided into two portions: cartilaginous and bony, covered by a thin layer of periosteum and skin. The bone portion is extraordinarily sensitive as a result of less cushioning over the skin and underlying periosteum, therefore resulting in attempts to extract foreign bodies being very painful. At the junction of the cartilaginous and bony portion is the isthmus, which is the narrowest portion of the canal and the main site for impaction of foreign bodies, adding difficulty to removal. Attempts to remove the foreign body may push it further into the canal and lodge it in this narrow spot [13].

4. Nasal cavities

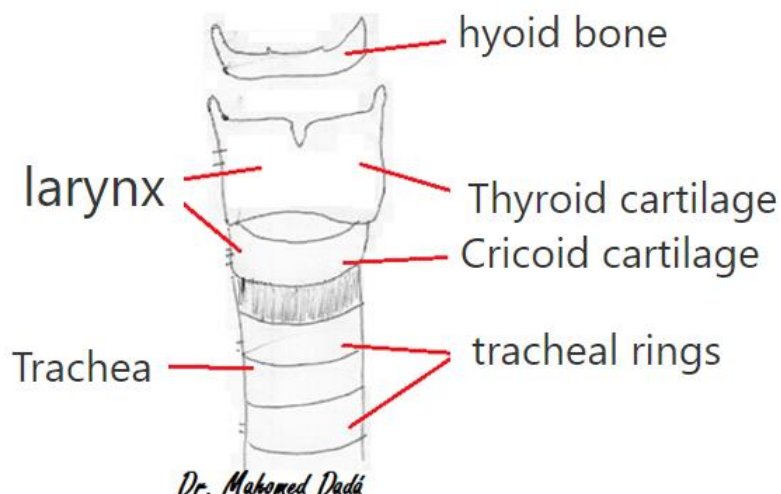
The nasal cavities are located in the middle of the face, below the orbital cavity and above the oral cavity. They communicate with the nasopharynx through the choanae. They have four walls, with the lateral wall being the most irregular with the insertion of three turbinate's. Nasal foreign bodies tend to be in one of two locations in the nasal passages: the floor of the inferior turbinate or in front of the middle turbinate [14]. Careless handling can transform nasal FB into bronchial FB and can often be fatal, especially if there is no time to extract the FB lodged in the lower airways.

5. Airways

Foreign bodies in the airways can lodge in the larynx, trachea, or bronchi. The size and shape of the object rule the location of the obstruction. The aspect of the item can be large, round, or expandable causing complete obstruction. When the patients present partial obstruction, presumably the FB has irregularly shape, allowing partial passage of air through the canal [15].

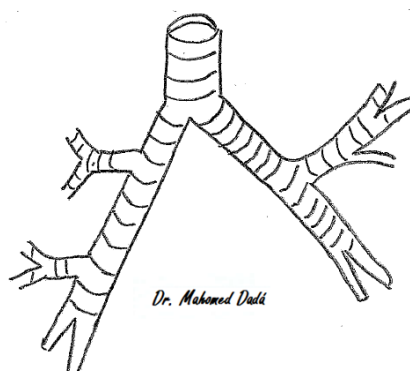
6. Larynx

Ossification of the thyroid cartilage begins at puberty, while in other cartilages it occurs later. Ossification in females happens much later. This fact is important to know so as not to confuse an ossified thyroid with a fishbone-like foreign body on the X-ray [16] (Figure 1).

Figure 1. Laryngeal cartilages.

7. Trachea

It is a tube in the form of an incomplete ring on the posterior surface that continues the larynx. It starts in the neck and ends in the chest, bifurcating into two main bronchi, in an area called the carina [17]. Given their shape as an air passage tube, FBs in the trachea are rare in clinical practice, because all those that lodge in the bronchi have a tracheal phase before definitively lodging in the bronchial tree. Only large FBs are impacted in the trachea [18]. The glottis space is smaller than the lumen of the trachea and any FB that crosses the larynx must be able to cross the glottis, but as the trachea is larger, they are not impacted in this position (Figure 2).

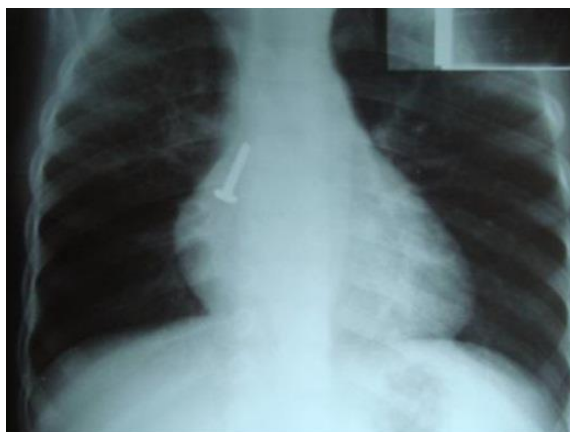
Figure 2. Trachea and bronchi.

8. Bronchus

The trachea ends by bifurcating into two bronchi. The bifurcation angle is different in each bronchus: the right bronchus is almost vertical (17°) (Figure 3) and therefore aspirated foreign bodies often lodge in this side, while the left bronchus makes an S-shaped curve (around 35°) [16]. The location of the FB in one of the bronchi depends on the patient's age and position at the time of the incident. Considering that the angle that forms between the trachea and the bronchi is similar until 15 years of age, we can find a FB in

any sides (if the patient is in an upright position) with the same probability. However, from this age onwards the main bronchi form different angles, with the right main bronchus being more vertical than the left, which facilitates the right-hand location of a FB [19] [20]. In a study carried out in the Netherlands [21] states that the location of a FB in the right bronchus is probably due to the fact that the parents, in an attempt to extract the FB, place the child on their left hand when strike several times the back with their right hand (if they are right-handed).

Figure 3. Chest x-ray of a 2-year-old child with a foreign body (screw) lodged in the right bronchus.



9. Digestive tract

Ingested foreign bodies must cross more than 800 cm of digestive tract before safely passing through the anus. Several areas of anatomic and physiologic narrowing exist along the GI tract where foreign bodies may become impacted. These natural barriers include [22]:

1. Cricopharyngeal muscle at the upper esophageal sphincter
2. Extrinsic compression of the aortic arch and the left mainstem bronchus
3. Lower esophageal sphincter at the junction between the esophagus and stomach.
4. Pylorus at the junction between the stomach and duodenum
5. C-Loop of the duodenum
6. Ligament of Treitz
7. Ileocecal valve adjoining the colon
8. Hepatic and splenic flexures in the transverse colon
9. Valves of Houston in the rectum.

10. Mouth

Foreign bodies in the oral cavity are more common in childhood, due to the child's oral phase to explore their bodies, unfortunately didn't presenting documented cases, because most of the time toddler are asymptomatic and parents solve it by themselves, but some cases have also been reported occurring after road accidents, with impaction of the soft tissues on oral cavity [23]. In dental care, due to repeated and habitual use of metallic devices, incidents occur because of poor-quality material and wear and tear, impacting in the maxillary, mandibular bone or soft tissues. The interdental space usually is affected by the poor-quality of dental floss jamming. The unexpected disappearance of a tooth or tools during dental procedures, such as drills, files, needles, among others, should be a cause of care for dentists, it may has become lodged in the soft tissues of the oral cavity, maxillary sinus or any other head and neck region [23].

11. Pharynx

The pharynx has three regions: nasopharynx, oropharynx and hypopharynx or laryngopharynx. FBs can impact these regions, but the nasopharyngeal region is very rare. At the level of the glossoepiglottic vallecula and the lingual tonsil, in the hypopharynx, fish bones or small animal bones may be retained. On adenotonsillectomies, gauzes applied to tamponade and for bleeding control can be forgotten in the nasopharynx.

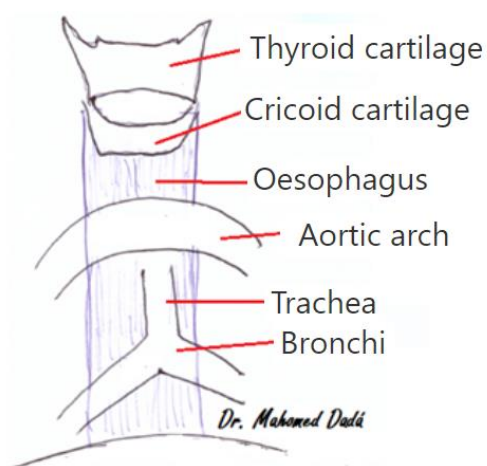
The foremost pharyngeal location is the oropharyngeal region, especially at the level of the palatine tonsil. This fact may be due to the presence of tonsillar crypts, which facilitate FB retention, and the morphology of the glossoepiglottic vallecula being hard to Visualize [24]. Attempted removal may push the foreign body into the airway creating an airway hazard. Pharyngeal trauma, including blunt FB trauma such as spines and bones, has the potential to cause complications with mediastinitis, a serious and potentially fatal nosologically entity, due to its intimate relationship with the retropharyngeal space and danger space. The hyoid bone can be jumbled as a pharyngeal or esophageal FB in professionals with lack of anatomical knowledge.

12. Esophagus

The esophagus is a musculomucosal tube belonging to the digestive system, located between the pharynx and the stomach, 25 cm long, slightly deviated to the left. The esophagus has four physiological narrowing places where foreign bodies such as coins, fish bones, pieces of bone, etc. normally become embedded [25] (Figure 4):

1. Cervical narrowing (upper esophageal sphincter) at the beginning of the pharyngo-esophageal union, approximately 15 cm from the incisor teeth, produced by the crossing of the cricopharyngeal muscle.
2. Aortic narrowing, produced by the crossing of the aortic arch, 22.5 cm from the incisor teeth.
3. Bronchial narrowing resulting from the crossing of the left main bronchus, 27.5 cm from the incisors.
4. Phrenic (diaphragmatic) narrowing when it passes through the esophageal hiatus of the diaphragm, 37.5 cm from the incisor teeth.

Figure 4. Esophageal structures.



Distribution of foreign bodies found in the different anatomical regions in patients seen at the ENT Department of the HCM from 1983 to 2009 revealed that most FBs are found in the ear, esophagus, and nasal cavities [2] (Table 1).

Table 1. Distribution of foreign bodies found in the different anatomical regions in Mozambican Hospital from 1983 to 2009.

FB location	Total	%
Mouth	9	0.2
Larynx	43	0.9
Pharynx	576	11.9
Esophagus	1539	31.9
Trachea	21	0.4
Bronchus	97	2.0
Nose	595	12.3
Ear	1946	40.3
	4826	100

13. Abdominal foreign bodies

The presence of foreign bodies in the abdomen is a medical condition that involves multiple specialties, as, depending on the case, it constitutes a subject of general surgery, gastroenterology, gynecology, pediatrics, psychiatry, forensic medicine and pathology, resulting of involuntary or intentional access by oral and rectal cavities or resulting from iatrogenic complications during therapeutic or surgical procedures, which has a special clinical and medico-legal interest, namely the placement of medical implants in the abdominal region for therapeutic purposes even incidents related to forgotten surgical items, such as gaze and forceps [26].

Foreign bodies that manage to pass through the lower esophageal sphincter and pylorus are more possible to be eliminated spontaneously (80-98% of cases). About 1% of cases will produce perforation or other serious complications [26]. The main population groups with the highest incidence of foreign bodies in the abdomen are children, elderly, patients with neurological disorders, people with neurodevelopmental or neurodegenerative disorders, prisoners, and drug addicts [26]. The most common anatomical sites of FB obstruction along the digestive tract are normal lumen constrictions, anatomical sphincters, acute angulations, curvatures, congenital deformities, tumors or sites of previous injury, surgical procedures that alter the anatomy of the area (e.g., adhesions or gastric rings) [26].

14. Foreign bodies in the small intestine

Foreign bodies at least 5 cm long can become trapped in the duodenal flexures, the duodeno-jejunal flexure, the area of the duodenal suspensory muscle (ligament of Treitz) and the ileocecal valve. Obstruction or perforation by sharp objects most often occurs in the terminal ileum and ileocecal valve [26]. Patients undergoing pyloromyotomy are more likely to suffer impaction from a foreign body. The ligament of Treitz or duodenal suspensory muscle is a fibromuscular band that suspends the duodenojejunal flexure to the right pillar of the diaphragm and is the main site for foreign body impaction due to its normal anatomical narrowing [27].

Foreign bodies ingested from the stomach and duodenum at initial presentation are usually asymptomatic. Occasionally, adults present with a history of ingestion of a true foreign body (pin in seamstresses, coins in college students), but usually without symptoms. This is contrary to the more common ingestion of meatloaf lodging in the esophagus in adults who have foreign body symptoms. If the FB is in the stomach and symptoms are present, they usually represent a complication (bleeding, perforation, obstruction). Gastrointestinal symptoms such as nausea, vomiting, hematemesis, abdominal pain, pain or fever in the context of a recently ingested foreign body suggest a complication. In children, the usual story is parental observation of the child placing an object in the mouth, which

is presumed to be swallowed. Occult foreign bodies (without observation of foreign body exposure) of the stomach or duodenum will usually present as a complication (bleeding, perforation, obstruction) in children with symptoms of vomiting, failure to thrive, fever, hematemesis. Patients with known gastric or duodenal foreign bodies who are being monitored for progression may present with symptoms of complications or simply failure of the object to displace distally [27].

15. Foreign bodies in the large intestine

Once the foreign body has passed through the ligament of Treitz, it is hard endoscopically to remove it. The patient will usually be asymptomatic until a complication such as perforation or bleeding occurs [27]. When the foreign body reaches the colon, it becomes mixed with fecal material, protecting the intestinal wall from possible trauma [22].

16. Rectum and anus

Anorectal foreign bodies are frequently found in Emergency Departments and some of them are potentially fatal. Various objects are commonly observed, such as fruits and vegetables, light bulbs, nails, and dildos [28]. Although Rectal FB have less intestine to cross, anatomy and physiology play a major role [22]. The interior of the rectum has two types of temporary and permanent mucosal folds. Temporary folds are mainly longitudinal and found in the lower part of the rectum and disappear when the rectum distends. There are four permanent folds (or Houston valves) and become more prominent when the rectum is distended. The third valve is the largest, most constant, and most important leading to blockage of the passage of an item introduced FB that manage to pass through the lower esophageal sphincter and pylorus are more likely to be eliminated spontaneously through the anus. Therefore, the rectal cannula for lavage and the sigmoidoscope are generally passed in the left lateral position of the patient to avoid injury to the third valve of Houston and unnecessary discomfort to the patient [29].

There are two sphincters (internal and external) surrounding the anal canal, which provide a powerful sphincter mechanism at the distal end of the gastrointestinal tract becoming tonically constricted and edematous after trauma, creating another barrier to extraction. This edema is often worsened by repeated attempts by the patient or partner to remove the foreign body before presenting to the emergency department [29]. The causes of FB insertion into the rectum include: anal auto-eroticism, concealment, attention-seeking behavior, accidental, aggression and to relieve constipation [30]. Patients with inserted anorectal foreign bodies generally have a long history of anorectal erotic stimulation and, as a result, may develop lax rectal tone, allowing insertion of increasingly larger foreign objects [27].

People who venture into transporting drugs internationally and to places where they are prohibited are coerced by traffickers into introducing or ingesting packs of amphetamine, cocaine, heroin or marijuana into their bodies. However, eventually the "mule" cannot reach its final destination, resulting in leakage of the contents, which can result on gastrointestinal obstruction and perforation [28]. To remove the foreign body, it is initially evaluated with a digital examination to discover the possible object and material that may interfere with the choice of the diagnostic method [31]. Extraction of anorectal FBs can be difficult due to the size, shape and migration of FB [32]. In the anamnesis of these patients, it is important to know their motivations and whether they are repetitive, in order to rule out behavioral pathology, misadventure or exploitative sexual behavior and devise different approach strategies [33].

17. Genitourinary

The United States has a national incidence of genitourinary FBs of 7.6/100,000 individuals per year, with 13.1/100,000 women per year and 1.7/ 100,000 men per year [34].

18. Vagina

The female reproductive system is divided into internal and external organs. The internal components include the vaginal canal, uterus, ovaries and fallopian tubes and the external part, composed by vulva or pudendum, pubic mound, labia majora, labia minora, clitoris and vestibule. Foreign bodies are found as a result of sexual satisfaction, hiding objects for passage in places or institutions where the object is prohibited, empirical lay treatment, contraception, induced abortion [35], psychiatric disorders, sexual abuse, especially child abuse and insertion curiosity, often leading to oblivion on the spot. However, these situations are more prevalent among the pediatric population [36].

Toys, metal and glass cups, screws, bottles containing aerosol substances and plastic packaging can be found [37]. In children and adolescents, the most common foreign bodies found are small rigid objects, pieces of toilet paper and tissue [38]. Because they feel embarrassed to report the case to health professionals, women omit important data for carrying out the extraction. Complications include urovaginal fistulas, which present secretion and a foul odor, causing discomfort to the patient [39]; vaginal fibrosis [35]; vulvovaginitis [40]; vesicovaginal fistula [41]; bleeding [42] and rectovaginal fistula [43].

19. Urethra

The insertion of objects into the urethra is chiefly related to autoeroticism, psychiatric disorders such as polyembolocholamania and cases of torture. Situations of torture with electric shock on genitals have been reported in patients with erectile dysfunction and urethral strictures [44]. Urethral fistula [45], dysuria, urinary tract infection, and urethral damage [46] may happen.

Complications

Abdominal foreign bodies can result in several complications, especially perforation of the hollow viscus, peritonitis, bleeding, and intestinal obstruction [27]. Complications due to surgical items retained in the abdominal region can produce [26]:

1. Abdominal pain with no other explanation
2. Presence of abdominal mass
3. Intra-abdominal bleeding
4. Perforation of abdominal organ
5. Intestinal obstruction
6. Fistula formation
7. Translocation to adjacent organ
8. Sepsis
9. Multiple complications (combination of the previous ones)
10. Others (weight loss, paralytic ileus, urinary retention, abdominal distension, nausea, vomiting, fever of unknown origin)

22. Conclusion

Foreign bodies are grouped in the trauma cluster in the International Classification of Disease ICD and are very common in all health units, from primary to quaternary levels. The clinical picture varies from asymptomatic to symptomatic and the symptoms vary depending on the anatomical location.

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