

Impaction of Foreign Body in Upper Digestive Tract: Unravelling the Anatomical Perspective

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Abstract

Context: A foreign body is any object in a region it is not meant to be, where it can cause harm by its mere presence and may require medical intervention if not spontaneously expelled from the body. Foreign bodies in the upper GI tract are usually swallowed, purposefully or accidentally which are more likely to be impacted at cricopharynx or esophagus. Present study identifies the pediatric population to be especially at a high risk of foreign body ingestion and our aim is to highlight the anatomical aspects contributing to this.

Aims: To identify the commonest site of impaction of foreign body in upper digestive tract and then study the causative anatomical factors leading to this.

Methods and Material: A Retrospective study conducted in the department of Otorhinolaryngology including previous records from 2014 onwards in tertiary care hospital of central India. A total of 160 patients of digestive tract foreign body were taken and categorized according to age, sex, site of impaction and type of foreign body.

Results: The foremost site of foreign body impaction is at Upper esophageal sphincter followed by upper 1/3rd of esophagus and commonest age group is 1-4 years.

Conclusions: Swallowing is not as coordinated and successful as in planned intake of bolus of food. This clearly affects the opening of UES leading to impaction of the foreign body at this commonest site followed by upper 1/3rd of esophagus and piriform fossa thereafter.

Keywords: Upper Esophageal Sphincter (UES); Cricopharynx; Foreign Body (FB); Piriform Fossa; Impaction; Pharyngeal Constrictors.

Introduction

Foreign body in ear, nose and upper aero-digestive tract are common occurrences forming a large share of the emergencies dealt by the otorhinolaryngologists in a tertiary care hospital. Virtually any object small enough to pass through the pharynx may be swallowed. Items commonly ingested by children include coins, small toys, pencils, pens and their tops, batteries, safety pins, needles, hairpins (which are mainly radio-opaque), beads, pebbles and popcorn-kernels. Food-related items, such as fish, meat and chicken bones, are more often ingested by older

children and adults and tend to be radiolucent. In adults, dentures or parts from dentures can be swallowed accidentally. Psychiatric disorder, alcohol intoxication, developmental delay and secondary gain seeking behaviour favour true foreign body ingestion (i.e non-food objects) in adults [1].

The majority of ingested foreign bodies will pass spontaneously but those that are retained need to be diagnosed and managed accordingly. We aim to first identify the common sites for impaction or retention of foreign body after accidental ingestion in upper digestive tract and secondly to find the anatomical reasons for the same. In one study showing the distribution of aeroesophageal FB, 90% of patients had a retained FB, while it passes in the other 10% [2]. Approximately 80% to 90% of ingested FBs are passed spontaneously without complications [3-5]. Radiographic evaluation including soft tissue lateral neck radiograph and wide chest radiograph of neck and chest suggests the level of impaction and gives clues regarding shape, size and nature of the foreign body. Coin and battery cell are usually oriented

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coronally in the esophagus mostly at the level of cricopharynx [6]. (UES- upper esophageal sphincter)

The pharynx is a musculo-membranous tube extending from the base of the skull to the level of the sixth cervical vertebra where it is continuous with the oesophagus. The interior of the pharynx is divided into three parts- nasopharynx (epipharynx), oropharynx (mesopharynx) and laryngopharynx (hypopharynx). The pharynx acts as a common channel for both deglutition and respiration, because the food and air passages cross each other in this region.

Dimensions of adult pharynx:

Length – 12 to 14 cm

Width – Maximum of about 3.5 cm in the nasopharynx

Minimum of about 1.5 cm at the Pharyngo-oesophageal junction (UES)

Structure of the pharynx : The wall of the pharynx presents from outside inwards the following coats: areolar (buccopharyngeal fascia), muscular, submucous (pharyngeal aponeurosis) and mucous.

Muscular coat : It consists of striated muscles which are arranged in outer circular and inner longitudinal layers. The circular layer comprises superior, middle and inferior constrictor muscles; the longitudinal layer consists of three paired muscles: stylopharyngeus, palatopharyngeus and salpingopharyngeus [7].

Materials and Methods

This is a retrospective study where data from January 2014 onwards till July 2017 was obtained from records of ENT department in tertiary care hospital in central India. We included 160 patients with history of accidental ingestion and impaction of foreign body in upper digestive tract specifically as per records in inpatient, outpatient and emergency care units referred to ENT department. These patients were categorized according to age, sex, site of impaction and type of foreign body which was then related to the anatomical factors contributing to such occurrences.

As per records, most of the foreign bodies were detected by plain X-ray chest AP and soft tissue neck lateral view along with X-ray barium swallow for radiolucent vegetative foreign bodies, plastic objects and mutton piece without bone. All foreign bodies were removed by rigid endoscopy under general anaesthesia and postoperative period was uneventful as per records.

Results

Out of 160 patients studied, 109 were males and 51 were females. The age group of the patients varied from 1 to 60 years. Around 60% of patients were in the age group 1-4 years owing to higher cases of accidental ingestion of foreign body (Chart 1).

Table 1:

Site	Cases	Percentage
Piriform fossa	2	1.25%
Post cricoid	1	0.625%
Cricopharynx (UES)	138	86.25%
Upper 1/3rd esophagus	18	11.25%
Middle 1/3rd esophagus	1	0.625%
Lower 1/3rd esophagus	0	0.00

Table 2:

Type of foreign Body	Cases	Percentage
Age 0-20 years		
Metallic object	127	79.37
Non-metallic Object	18	11.25
Age 20-40 years		
Metallic object	02	1.25
Non-metallic Object	09	5.63
Age 40-60 years		
Meat bone	3	1.875
Age >60 years		
Denture	1	0.625

Total No. of Patients

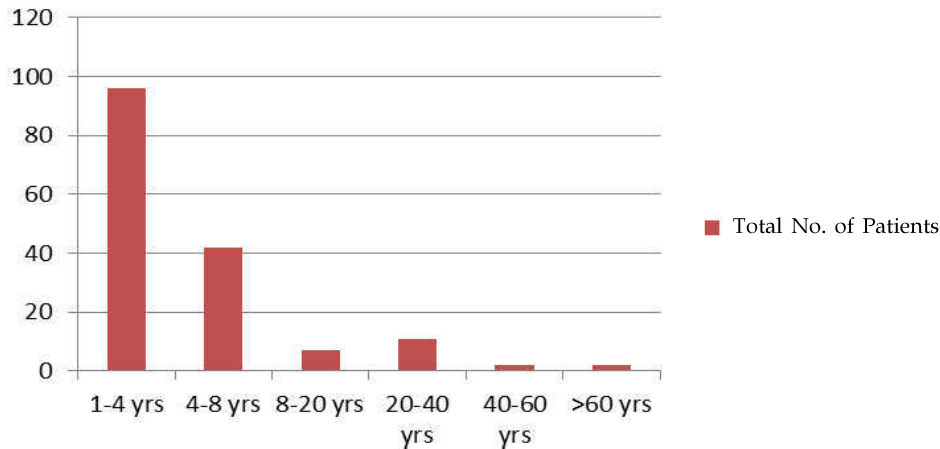


Chart 1:

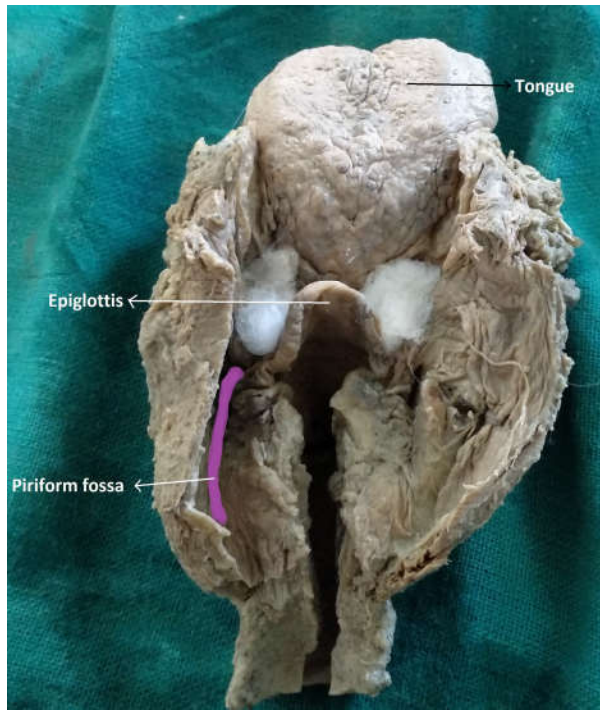


Fig. 1: Image of specimen of tongue, pharynx and larynx showing cotton placed in vallecula and extent of piriform fossa marked on the left side

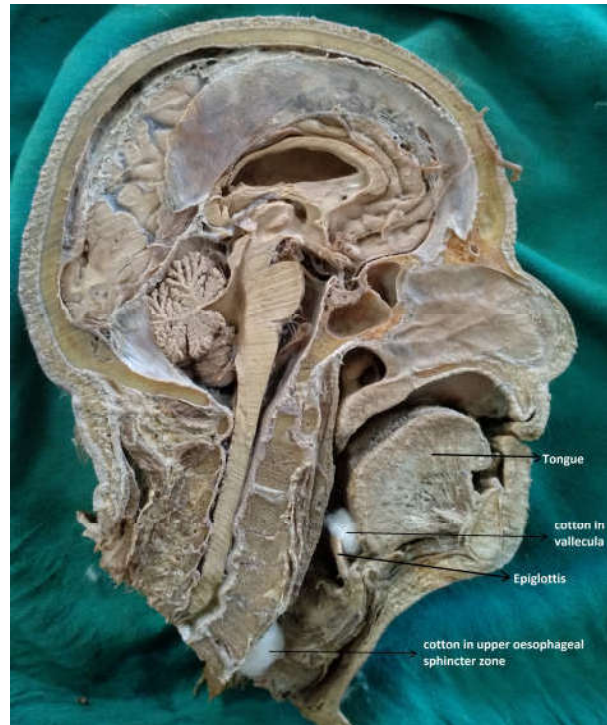


Fig. 2: Image of sagittal section head and neck showing cotton placed in vallecula and upper esophageal sphincter zone

According to the data obtained; most common site of impaction was Cricopharynx (UES-upper oesophageal sphincter) in 86.25% cases followed by upper 1/3rd of oesophagus in 11.25% cases and piriform fossa in 1.25% cases. Solitary cases of impaction in post-cricoid region and middle 1/3rd of oesophagus were also reported. (Table 1).

In the age group 1-20 years, metallic foreign bodies were found more frequently (79.37% cases) including coins, batteries, safety pins, needles and hair pins

while non-metallic foreign bodies including plastic toys, pencils and vegetative seeds were found in 11.25% cases.

With advancing age, non-metallic foreign bodies were more commonly found in 5.63% of cases as compared to metallic foreign bodies in only 1.25% cases in the age group of 20-40 years. In the age group of 40-60 years, meat bones were found in 1.875% cases and a solitary case of denture impaction was reported in the age group >60 years. (Table 2).

Discussion

Sphincters are found in the respiratory, genitourinary and especially alimentary tracts considering the complex changes of physical and chemical form which take place in ingested materials during their delayed passage from mouth to anus. It is this delay which is one of the essential functions of the alimentary sphincters [8]. Upper esophageal sphincter (UES) has also been referred to as the inferior pharyngeal sphincter because it is located at the lower end of pharynx and guards the entrance into the esophagus. It is the narrowest part of the alimentary tract (except for the vermiform appendix) and is constricted at the beginning (15 cm from the incisor teeth), It has two major functions: (1) to prevent air from entering into the esophagus during breathing and (2) to prevent reflux of esophageal contents into the pharynx to guard airway aspiration [9].

Anatomically, there are three well recognized sphincter mechanisms to be considered in the pharyngeal region of the gastro-intestinal tract. First, the palatopharyngeal sphincter which prevents the bolus from passing upwards into the nasopharynx while swallowing. Second, the larynx which prevents the inhalation of swallowed liquids and solids. And third the crico-pharyngeus which acts as an upper esophageal sphincter which relaxes to allow the bolus to pass into the esophagus. In our study it is this site where we found maximum number of cases (86.25%) presenting with foreign body impaction. This is also in accordance with the findings in the study conducted by Park SM, Chung MS, Choi JY, et al [10].

Considering from an anatomical point of view; we know that the constrictor muscles take limited origin from the front (bones, ligaments or cartilages) and possess expanded insertion behind in a median fibrous raphe extending from the pharyngeal tubercle at the basi-occiput to the pharyngo-oesophageal junction. Close to the insertion, the constrictors overlap one another from below upwards like the placing of three flower pots one within the other [7].

The superior constrictor constricts the upper part of the pharynx while the middle constrictor constricts the middle part of the pharynx during swallowing. The inferior constrictor is the thickest of the three constrictor muscles, and is usually described in two parts, thyropharyngeus and cricopharyngeus. Thyropharyngeus arises from the oblique line of the thyroid lamina, a strip of the lamina behind this, and by a small slip from the inferior cornu. Some additional fibres arise from a tendinous cord that loops over cricothyroid. Cricopharyngeus arises from the side

of the cricoid cartilage between the attachment of cricothyroid and the articular facet for the inferior thyroid cornu. It consists of a superficial upper oblique portion, the pars oblique, and a lower, deeper, transverse portion, the pars fundiformis. The upper part attaches to the median raphe while the lower part forms a circular band that lacks a median raphe. The area demarcated by the pars oblique and pars fundiformis of cricopharyngeus is termed Killian's dehiscence (or Killian's triangle). A second triangular area, Laimer's triangle, can be identified beneath cricopharyngeus between the longitudinal fibres of the oesophagus as they pass laterally on either side to attach to the cricoid cartilage: only the circular muscle of the oesophagus forms the wall here. Both triangles are postulated to be sites of weakness in the wall of the pharynx and oesophagus, and are therefore areas where diverticula could potentially form. Both cricopharyngeus and thyropharyngeus spread posteromedially to join the contralateral muscle. Thyropharyngeus is inserted into the median pharyngeal raphe and its ascending fibres surround the middle constrictor muscle where the lumen of the pharynx is widest however, descending from this point, the lumen decreases in size and is at its narrowest at the level of the circular fibres of the cricopharyngeus muscle [11]. This anatomical difference is functionally highlighted during the act of swallowing where in the middle constrictor muscle and the thyropharyngeal part of the inferior constrictor act as propulsive muscles for the bolus, while cricopharyngeus acts as the sphincteric part of the muscle that relaxes to allow the passage of the bolus into the oesophagus.

Thyropharyngeus constricts the lower part of the pharynx. Cricopharyngeus is the main component of the upper oesophageal sphincter, or pharyngoesophageal high-pressure zone, the other parts being thyropharyngeus and the proximal cervical oesophagus. (The extent to which the lower fibres of thyropharyngeus and the upper fibres of the oesophageal musculature are involved in closing the upper end of the oesophagus appears to depend on the physiological state, whereas cricopharyngeus always participates in closure). The upper oesophageal sphincter is defined manometrically as a region of elevated intraluminal pressure, 2-4 cm long, located at the junction of the hypopharynx and cervical oesophagus. Normal UES pressure is approximately 100mm Hg in the antero-posterior direction and approximately 50mm Hg laterally. UES pressure is distributed predominantly in the anterior-posterior directions; lateral pressures are about 33% of the anterior-posterior ones [9].

Cricopharyngeus contains about 40% of endomysial connective tissue, much of which is elastic, but it lacks muscle spindles. It contains both slow-twitch type I and fast-twitch type II fibres, a structural arrangement that underpins the various functions of the upper oesophageal sphincter, i.e. maintaining constant basal tone, yet being able to relax and contract rapidly during swallowing, belching and vomiting. The tonic activity of cricopharyngeus between swallows prevents influx of air during inspiration and tracheobronchial aspiration and pharyngeal reflux of oesophageal contents during oesophageal peristalsis [12].

Swallow-induced relaxation of the UES lasts for 0.32–0.5 seconds and is directly related to the bolus volume [13]. Two distinct events are responsible for the swallow-induced relaxation of UES: (1) cessation of tonic discharges of the motor neurons of nucleus ambiguus and (2) anterior and superior lift of the hyoid, cricoids, and UES by the contraction of suprahyoid muscles. Cessation of motor neuron discharges causes UES relaxation which is seen as the cessation of EMG activity in the cricopharyngeus and thyropharyngeus muscles. A residual UES pressure of 10–15 mm Hg [14], following cessation of the EMG activity in these muscles, is because of the viscoelastic properties of muscle and surrounding structures. The residual UES pressure is ablated by a forceful superior (2.5 cm) and anterior (0.75 cm) stretch exerted on the UES by contraction of suprahyoid muscles (geniohyoid and mylohyoid), which results in the UES opening. Extent of UES opening is related to bolus volume and bolus pressure. UES during a swallow is described as a grabber because it ascends to grab the bolus and then descends with it.

It is well known that the esophagus has four areas of physiological narrowing. Apart from the earlier mentioned upper esophageal sphincter; the others include: eminence of the aortic arch (22.5 cm from the incisor teeth), the left main bronchus (27.5 cm from the incisors), and the lower esophageal sphincter (40 cm from the incisors) [11]. The esophageal stage of swallowing is achieved by sequential contractions of the circular and longitudinal esophageal muscles which are controlled by medullary swallowing centers via vagus nerve. The anatomical constrictions accompanied by functional disturbances in sequential contractions may be responsible for the upper 1/3rd oesophagus being the 2nd commonest site of foreign body impaction in our study.

Also lateral to epiglottis are the pharyngo-epiglottic or lateral glosso-epiglottic folds which are regarded as forming the upper boundary of the hypopharynx and beneath the level of these folds the hypopharynx

expands antero-laterally between the inner surface of the thyroid cartilage and the postero-lateral surfaces of the arytenoid and cricoid cartilages. These bilateral expansions are the piriform sinuses, recesses or fossae. Closure of laryngeal inlet during deglutition takes place by the apposition of the aryepiglottic folds due to the contraction of aryepiglotticus muscles. These aryepiglottic folds forming the medial boundary of the piriform fossa are kept upright by the backward pull of posterior crico-arytenoids on the arytenoid cartilages and the cuneiform cartilages acting as a passive prop [7]. It is probably reasonable to assume that the sequence of events that close the glottis may alter according to the type of swallow and consistency of the bolus. The sequential contraction by the constrictors of pharynx including propulsive force by the base of tongue may facilitate clearance ('stripping') of the pharyngeal walls and piriform sinuses. If this is so, residues that remain in the vallecula must reflect inadequate tongue force generation at the end of the oral phase of swallowing. Foreign bodies not infrequently lodge here and this is the 3rd commonest site of foreign body impaction in our study. In accidental ingestion swallowing is not as coordinated and successful as in planned intake of bolus of food. This clearly affects the opening of UES leading to impaction of the foreign body at this commonest site followed by upper 1/3rd of esophagus and piriform fossa thereafter. The entire process of swallowing is closely coordinated through the medullary swallowing centres [15].

In the adult, the tip of the epiglottis is significantly lower than the inferior edge of the soft palate while in the neonate, the larynx is high in the neck and the epiglottis may extend above the soft palate so that the laryngeal airway is in direct continuity with the posterior nares in neonates. The pediatric population shows a higher propensity of placing every object in their mouth due to their inquisitive nature besides contributory factors like playing, boredom, imitation, crying, laughing and immature swallowing coordination. Mental retardation, insanity, attention deficit disorder along with availability of objects and absence of watchful caregivers further enhance instances of foreign body ingestion in children [16].

The presenting symptoms were sudden onset dysphagia to solids, pain in throat, vomiting, epigastric pain, cough, dyspnea, stridor and mild distress as per case history records in our study. Impaction of a foreign body in the esophagus causes edema of the mucosa, and the esophageal wall becomes weakened. Retention leads to perforation, which is only a matter of time. Therefore, all foreign bodies retained in the esophagus should be removed

as soon as diagnosed [17,18]. The upper esophageal sphincter (UES) is located at the level of C5-C6 [19] as reflected in the sagittal section (Figure 2). The cricopharyngeus, attached to the posterior laminae of the cricoid cartilage is considered responsible for the sling effect that results in a high pressure zone at the esophageal opening.

Conclusion

Commonest site of impaction of foreign body in upper digestive tract in humans is the upper oesophageal sphincter zone followed by upper 1/3rd of esophagus and piriform fossa thereafter. The opening of the UES due to its active relaxation from the usually tonic cricopharyngeus is a vital step in preparing to convert the pharynx into a majorly swallowing pathway before the beginning of the pharyngeal stage in anticipation of the arrival of a food bolus. So during accidental ingestion of a foreign body, the medullary control in preparing the pharynx for swallowing is not as coordinated and successful as in planned intake of bolus of food.

Acknowledgement

Nil

Conflict of Interest

None

Key Messages

Anatomical dimensions and constitutions of the upper esophageal sphincter zone along with medullary control of swallowing are the major determining factors for impaction of accidental ingestion of foreign body in upper digestive tract in humans.

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