CLINICAL PROFILE, OUTCOME AND FOLLOW-UP OF FOREIGN BODY ASPIRATION IN CHILDREN

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CERTIFICATE

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INTRODUCTION

HISTORY

Prior to the 20th century, a foreign body in the lung led to a long and torturous illness, frequently ending in death. In his paper, "A Practical Treatise on Foreign Bodies in the Air Passages", in the year 1854, Dr.Samuel D. Gross of the University of Louisville complied more than 200 cases of foreign body aspiration and demonstrated a significant rate of morbidity and mortality in victims of such accidents. He described the early management of airway foreign bodies, including the use of emetics, sternutatories, expectorants, purgatives, and blood-letting.

Gustav Killian successfully examined the bronchus of an adult male using a 9mm rigid tube, and subsequently used his tube to perform the first endoscopic removal of a foreign body from the airway in 1897.

However, the addition of the Hopkins rod lens telescope to bronchoscopy in 1968 again revolutionized the procedure, bringing vastly improved illumination and visualization. Using glass rods instead of small lenses and glass fibers to carry the light, this instrumentation produced increased depth of field, a wider angle of vision, and a brighter image using less space. With the design of special extraction forceps capable of carrying

the telescope into the bronchi, visualization during foreign body removal was also improved and the rate of associated complications was diminished.

ANATOMY

Larynx

The larynx is a respiratory organ, set in the respiratory tract between the pharynx and trachea. It lies below the hyoid bone in the midline of the neck where the laryngeal prominence, commonly known as Adam's apple, is the most obvious part. It projects backwards into the laryngeal part of the pharynx where the inlet of the larynx is situated. The larynx becomes continuous with the trachea at the level of C6 vertebra.

TRACHEA

The trachea which begins at the level of C6 vertebra is in continuity with the larynx, being attached to the lower margin of the cricoid cartilage by the cricotracheal ligment. Its patency as an airway is maintained by the presence in its wall of a series of C-shaped hyaline cartilages (commonly) called rings (although they are never complete circles) joined together by a fibroelastic membrane. The gaps in the C-shaped rings lie posteriorly and this part of the trachea is closed by a sheet of visceral muscle, the

trachealis. From the neck the trachea passes into the thorax, and so has cervical and thoracic parts.

The cervical part lies in the midline of the neck, in contract with the front of the oesophagus. In the groove between trachea and oesophagus runs the recurrent laryngeal nerve. To the side of the trachea is the carotid sheath. The isthmus of the thyroid gland is adherent to the second, third and fourth tracheal rings and the lobes of the gland lie against the lateral side of the trachea as far down as the sixth ring. The inferior thyroid veins and anterior jugular venous arch lie in front, and also (if present) the thyroidea ima artery, the levator glandulae thyroideae and the upper end of a persistently large thymus. It is important to appreciate that, because of the shape of the lower cervical and upper thoracic parts of the vertebral column, the trachea passes not only downwards but backwards as well. Although just below the skin at cricoid level, it is 2 cm or more deep to the front of the jugular notch.

Entering the thoracic inlet in the midline it passes downwards and backwards behind the manubrium to bifurcate into the two principal or main bronchi on a level just below the lower border of the manubrium. The cricoid cartilage and sternal angle provide easy surface markings for the upper and lower ends of the trachea.

The thoracic part runs through the superior mediastinum in front of the oesophagus to the upper part of the posterior mediastinum. In front of this part are the manubrium with sternohyoid and sternothyroid attached on each side, the inferior thyroid and left brachiocephalic veins and the remains of the thymus. The brachiocephalic and left common carotid arteries diverge on either side. The right side of the trachea is separated from the lung by the pleura which plasters the vagus nerve against the side of the tracheal wall, and the arch of the azygos vein hooks forwards over the right bronchus. The right brachiocephalic vein and superior vena cava are anterolateral to the trachea. On the left the left common carotid and subclavian arteries prevent the pleura from coming into contact with the trachea as it does on the right, and the arch of the aorta hooks backwards over the left bronchus, with the left recurrent laryngeal nerve passing upwards in the groove between trachea and oesophagus.

LUNGS

Each **lung,** consisting of two lobes on the left and there on the right, lies within its own side of the thoracic cavity and is surrounded by the visceral layer of the pleura. Each has a principal or main bronchus, one pulmonary artery and two pulmonary veins, all of which undergo subdivision within the lungs substance, together with bronchial vessels, nerves and lymphatics. The region where the lung is connected to the

mediastinum, largely by the bronchus and pulmonary vessels, is the root of the lung, and the region of the lung where these structures enter or leave is the hilum.

LOBAR AND SEGMENTAL BRONCHI

Because the left lung grows into a smaller cavity than the right, the way bronchi divide to supply segments of lung is not identical on the two sides, although there are close similarities.

From the bifurcation of the trachea each main bronchus passes downwards and laterally to enter the hilum of the lung. The right is slightly shorter and more vertical than the left. At the bifurcation and anteroposterior internal ridge, the carina, lies to the left of the midline, so that foreign bodies that fall down the trachea are more likely to enter the right bronchus.

Each main bronchus gives rise to lobar bronchi that supply the lobes of the lung. The right main bronchus gives off the upper lobe bronchus outside the hilum and ends with the hilum by dividing into middle and lower lobe bronchi. The left main bronchus divides within the hilum into upper and lower lobar bronchi. The tissues of the bronchi are supplied by the bronchial arteries. The veins of the right main bronchus drain to the azygos vein and those of the left to the accessory hemiazygos vein.

Each lobar bronchus gives rise to further branches, the **segmental bronchi**, for each segment of the lung. There are typically 10 **bronchopulmonary segments** in each lung and therefore individual segmental bronchi are to be expected. Ten individual segmental bronchi can usually be distinguished on the right, but on the left it is usual for one or more segmental bronchi to share a common stem. Each lung segment is roughly pyramidal in shape, with its apex towards the hilum and base towards the surface of the lung. The bronchopulmonary segments are given the same names and numbers as the segmental bronchi, which are listed as

RIGHT LUNG	**LEFT LUNG**
Upper Lobe	***Upper Lobe***
1. Apical	1. } Apicoposterior
2. Posterior	2. }
3. Anterior	3. Anterior
Middle Lobe	
4. Lateral	4. Superior lingular
5. Medial	5. Inferior lingular
Lower Lobe	***Lower Lobe***
6. Apical (superior)	6. Apical (superior)
7. Medical basal (cardiac)	7. Medical basal (cardiac)

8. Anterior basal	8. Anterior basal
9. Lateral basal	9. Lateral basal
10. Posterior basal	10. Posterior basal.

PHYSIOLOGY OF SWALLOWING

The swallowing mechanism can be divided into four phases: the preparatory phase, the oral phase, the pharyngeal phase, and the esophageal phase. The first two phases are under voluntary control, and the next two are reflexes. In the preparatory phase, food is taken into the oral cavity and prepared into a bolus held between the hard palate and central anterior two thirds of the tongue. While food is being chewed, it is prevented from passing into the pharynx by apposition of the base of the tongue with the soft palate. During the oral phase, the anterior tongue elevates and contacts the hard palate, the soft palate closes off the nasopharynx, and the food bolus is pushed into the pharynx. Several investigators have discussed the physiologic aspects of sucking and swallowing in normal and abnormal infants. Squeezing the liquid from the nipple seems to be part of the infant's oral phase. Indeed, it appears that sucking is only half as effective as squeezing liquid from a nipple.

The pharyngeal phase begins reflexively when the bolus passes the tonsillar pillars. A conduit, the palatopharyngeal partition, is formed by the

apposing pharyngeal constrictors, palate, and palatopharyngeus. This conduit directs the food into the hypopharynx. At this point, the tongue base elevates against the posterior pharyngeal wall, the pharynx and larynx elevate, and the prepared food is engulfed.

Opening of the circopharyngeus muscle initiates the fourth phase of swallowing, the esophageal phase. As this phase begins, several events occur. The cricopharyngeus relaxes, respiration stops, the glottis closes, the nasopharynx is occluded by the velum, and peristalsis begins.

The last two phases of swallowing are reflex actions. The afferent limb consists of sensory and proprioceptive fibers in the glossopharyngeal, trigeminal, and superior laryngeal nerves. Impulses are transmitted to the swallowing center in the floor of the fourth ventricle. The efferent limb begins in the nucleus ambiguous of the medullar and descends in the vagus.

There are three limbs to the mechanism of airway protection in the normal person. First, the larynx acts as a sphincter that guards the respiratory tract from particulate invasion. There are three tiers to this sphincter, and these are, from superior to inferior, the epiglottis and aryepiglottic folds, the false vocal folds, and the true vocal folds. The second limb of airway protection is cough, initiated by sensory receptors in the epithelium of the large and small airways. During a cough, air leaves

the trachea at high speeds assisting in the mucociliary clearance of debris deposited in the tracheobronchial tree. The last limb of protection is swallowing, which clears material from the larynx and oropharynx.

The swallowing mechanism of children varies in several ways form that of adults. Because the hard palate is relatively closer to the base of the skull in children, angulation of the soft palate during nasopharyngeal closure is not a prominent feature. The adenoid pad also contributes to closure in children. In addition, the tonsils acts as directors of small quantities of food into the oropharynx and help to keep the airway open until the child is ready to swallow. Because the larynx is relatively higher in the neck in children, there is less upper and posterior movement of the hyoid and larynx. Finally, the swallowing frequency during sleep in the adult is one sixtieth that of the sleeping preterm infant (six swallows per minute).

EPIDEMIOLOGY

In the pediatric age group, most victims of foreign body aspiration are older infants and toddlers. According to case series from the last decade, children younger than 5 years of age account for approximately 84% of cases (range, 74-96%), and children younger than 3 years account

for 74% of cases (range, 52-90%). Boys are affected more frequently than girls, by a ratio of about 2:1.

The reason for the male predominance remains unclear, but the high incidence in this age group reflects the tendency of these children to explore their world using their mouths. Furthermore, these children have not yet developed a full posterior dentition, and neuromuscular mechanisms for swallowing and airway protection may not be fully mature. As a result, chunks of food are often too large and may cause gagging. If they cannot be moved into the hypopharynx, they may obscure the laryngeal inlet when the child inspires.

PRESENTATION

Aspiration of foreign bodies usually causes significant coughing, choking, gagging, and wheezing in a short time, that calling attention to the problem. However, in many cases the diagnosis is delayed, usually because the ingestion was not witnessed, because there were no symptoms or signs, or because the presence of a foreign body was not suspected when symptoms and signs did appear. Foreign bodies may be the cause of the variety of acute and chronic diseases of the lung and should be considered in differential diagnoses. Also, when no signs or symptoms are present, the physician may be misled into assuming that an object has been swallowed

and will safely pass through the digestive tract. The mucosa of the larynx, trachea, and bronchi rapidly adapts to the presence of foreign objects, and the physician must be aware that symptoms and signs may not appear immediately.

The practice of treating asthmatic or "croupy" children with antibiotics or steroids may well obscure signs and symptoms that would normally be expected with a retained foreign object. Clearing of symptoms with these agents cannot always be assumed to be diagnostic of a specific disease process. The fact that a wheeze disappears or that a pneumonic process clears may merely mean that a patient's reaction to the presence of the foreign object has been temporarily controlled. The recurrence of "asthma" after the withdrawal of therapy should heighten the physician's suspicion of a foreign object as the possible underlying cause of distress.

Clinical Stages of Foreign Body Aspiration

Signs and symptoms associated with foreign body aspiration are observed in three stages. In the initial stage, there is a history of a chocking episode, followed by violent paroxysms of coughing, gagging, and, occasionally, complete airway obstruction. Unfortunately, many parents tend to downplay the significance of such an episode or do not recount the history until after the foreign body has been removed.

An asymptomatic interval generally follows the aspiration, during which time the foreign body becomes lodged, the reflexes become fatigued, and the immediate irritating symptoms subside. This stage is most treacherous and accounts for a large percentage of delayed diagnoses or overlooked foreign bodies. Longer delays in diagnosis appear to correlate with increasing age.

The third stage is characterized by symptoms of complications. It is the stage in which obstruction, erosion, or infection develops to again direct attention to the presence of the foreign body. Cough, hemoptysis, pneumonia, lung abscess, fever, and malaise may develop with foreign bodies of the airway.

Laryngeal Foreign Body

As mentioned previously, foreign bodies lodging in the larynx that are completely obstructive usually cause sudden death. Objects that are only partially obstructive and thus compatible with life are usually flat and thin and lodge between the vocal folds in the sagittal plane. Such objects will commonly cause hoarseness, croupy cough, stridor, and varying degrees of dyspnea, all of which increase as edema and infection develop.

Tracheal Foreign Body

Foreign bodies of the trachea present in a manner similar to those of the larynx, with the exception that hoarseness is a less common finding.

Three additional features originally described by Jackson and recounted by McCrae are pathognomonic for tracheal foreign body. The audible slap results from the impact of a mobile foreign body against the wall of the trachea on deep inspiration or coughing and is best heard at the open mouth. The same movement also creates a simultaneous palpatory thud, which can be felt with one finger on the trachea. The asthmatoid wheeze is in fact higher in pitch and more intense than that of bronchial asthma. It is best heard at the open mouth or with a stethoscope over the trachea and is poorly heard over the chest.

Bronchial Foreign Body

The initial symptoms of bronchial foreign body are those mentioned previously, including chocking, coughing, and wheezing. However, in one large series, 33% of patients with bronchial foreign bodies presented with none of these symptoms. Choking and coughing were found to be highly suggestive of foreign body aspiration (specificity of 91% and 80%, respectively), but the diagnostic sensitivity of both was considerably lower (less than 40%). Such data lend credence to the aphorism, “A positive history must never be ignored, while a negative history may be misleading.”

Common physical signs of bronchial foreign body include expiratory wheezing and decreased air entry on the affected side. However, although such differences often suggest the presence of a foreign body, they are an unreliable means of localizing the object, as conditions in the airway may vary over time. Secretions, whether normal or pathologic, may shift from one location to another. The foreign body itself may shift in position, and thus there may be variation in the aeration distal to the foreign object. Foreign bodies in the lower trachea may give rise to a variety of signs and symptoms as the foreign body shifts its position in the region of the carina.

Respiratory distress is a relatively uncommon finding in children with bronchial foreign bodies, but such patients require immediate attention and intervention. Dry vegetables and beans that swell as they become moist from bronchial secretions are often responsible in these cases. Hemoptysis, also a rare finding, suggests.

Late manifestations may be obscured by the prior treatment of the patient with steroids or antibiotics. Obstructive bronchial foreign bodies classically cause emphysema, atelectasis, pneumonia, and, eventually, pulmonary abscess. Organic materials are apt to cause a relatively violent reaction, with symptoms of laryngotracheobronchitis, toxemia, cough, and irregular fever.

Types of Airway Foreign Bodies

The spectrum of airway foreign bodies varies somewhat from country to country, depending on the diet and customs of the population in questions. Nevertheless, vegetable matter is uniformly the most common foreign body found in the pediatric airway. Such material is found in 55% to 95% of cases, with peanuts, and other nuts alone accounting for an average of 39% (range, 7-58%). Nuts with oils on the surface tend to stimulate a robust inflammatory mucosal response. Dried beans may also be associated with greater morbidity because of their tendency to swell when exposed to secretions in the airway.

Because of their nonirritating and radiolucent qualities, plastics may remain as foreign bodies in the tracheobronchial free for prolonged periods of time.

Location of Airway Foreign Bodies

Most foreign bodies pass through the larynx and trachea to become lodged more peripherally in the airway. However, large foreign bodies or those with sharp, irregular edges may become lodged in the laryngeal inlet. This occurrence is particularly common in infants younger than 1 year of age. Such objects account for 1% to 7% of airway foreign bodies.

Once a foreign object traverses the larynx and enters the trachea, its final resting place is determined by several factors. Tracheal foreign bodies, found in 3% to 12% of cases, are more likely if the tracheal lumen is narrowed by tracheomalacia or previous surgery, or if the patient's respiratory effort is weak. Occasionally, a longstanding esophageal foreign body may erode through the party wall and present in the trachea. In most cases, however, the foreign body finds its way into one of the main bronchi, the right being more frequently involved than the left in most series. Explanations for the predominance of the right main bronchus include its greater diameter, its smaller angle of divergence from the trachea axis, greater airflow through the lung, and the position of the carina to the left of the midline. In a study of adult cadavers in which peanuts were passed into the trachea and the final site of lodgment noted, only the position of the carina was felt to correlate with foreign body location.

Imaging

Radiographic examination for airway foreign bodies consists of anteroposterior and lateral views of the extended neck for soft tissue visualization and posteroanterior and lateral radiographs of the chest. Smaller children may undergo lateral chest radiography with the arms behind the back, the neck flexed, and the head extended to allow for visualization of the entire airway from the mouth to the carina. Radiographs

of the chest in inspiration and expiration are the most useful radiographs for demonstrating unilateral air trapping. Because these views are difficult to obtain in children, lateral decubitus radiographs are often performed in order to use the patient body weight to promote expiratory excursion. Dynamic imaging by fluoroscopy is useful for studying partial obstruction of the lung in real time; complete ventilation of the lung maybe demonstrated if given enough time.

When a foreign body is present at the orifice of a main bronchus, obstruction may be partial or complete. In partial bypass valve obstruction, air is exchanged in both inspiration and expiration, resulting in a normal radiographic study. Check valve obstruction is commonly associated with acute bronchial foreign bodies. In such cases, air can move past the foreign body on inhalation but not on expiration due to the normal physiologic decrease in bronchial diameter. The result is hyperinflation of the obstructed lung and mediastinal shift to the opposite side. Long standing foreign bodies cause edema and granulation tissue, resulting in complete, or stop valve obstruction and a chest radiograph that demonstrates collapse of the affected segment. Ball valve obstruction rarely seen in cases of bronchial foreign body, and egress of air from the lung but prevents entrance of on inhalation. Such obstruction leads to atelectasis and mediastinal shift towards the obstructed side.

FLEXIBLE FIBEROPTIC BRONCHOSCOPY IN CHILDREN

Flexible fiberoptic bronchoscopy have become useful techniques in evaluating respiratory disease in infants or children. It can be done on an outpatient basis. The first instrument developed for pediatric use was the 3.5-mm tip-diameter instrument. This bronchoscope contains a channel for the instillation of topical anesthetics or saline solution and the aspiration of lower airway specimens. It can be passed through the nose of most infants and is appropriate for most pediatric procedures. A small 2.7-mm instrument is particularly well suited to infant bronchoscopy but does not contain a suction channel. Topical anesthesia is provided by instillation into the nares of 1% lidocaine and by administering 1% lidocaine onto the larynx and vocal cords, trachea, and lower airway through the bronchoscope channel. A narcotic such as meperidine or fentanyl and midazolam, provided in carefully titrated doses, may also be used. Skill in airway management and respiratory support is required, and monitoring and an environment conducive to ongoing assessment and intervention are essential.

In the outpatient setting, flexible bronchoscopy is commonly done to evaluate airway anatomy. Indications for FFB included stridor, abnormal chest roentgenogram, airway evaluation in patients with tracheostomy,

airway obstruction, hoarseness, recurrent pneumonia, chronic cough, failed extubation, tracheal injury, and hemoptysis (19).

Complications of flexible bronchoscopy are generally infrequent. Minor complications occur in 2% to 3% and include epistaxis, transient bradycardia, and adverse reactions to anesthetic agents. Major complications, which include infection, pneumothorax, and laryngospasm, occur in about 0.4% of lower airway examinations. Death has been reported but is such an infrequent occurrence that it is rare even in large series.

Further applications and improvements in technique and instrumentation can only be expected as pediatric flexible bronchoscopy enters its second decade.

MANAGEMENT

In acute stage

The most serious sequela of foreign body aspiration is complete obstruction of the airway. In such cases, the foreign body becomes lodged in the larynx or trachea, leaving little room peripherally for air exchange. Globular food objects such as nuts and seeds are the most frequent offenders, while plastic objects and other toys are most common among nonfood objects.

Recognition of the child with complete airway obstruction is critical to the success of first aid efforts. Coughing, gagging, and throat clearing are reflexes that protect the airway and indicate that obstruction is not yet complete. First aid delivered to such a child is unnecessary and potentially dangerous. Probing the hypopharynx with a finger may impact a loose foreign body tightly into the larynx, thus transforming partial obstruction into complete obstruction. The foreign body may also be forced into the esophagus, where compression of the trachea against the upper sternum causes an obstruction that cannot be relieved even by tracheotomy. Similarly, back blows with the victim inverted are also ill-advised in the incompletely obstructed child. Such treatment may cause a bronchial or lower tracheal foreign body to impact in the glottis from below, precipitating complete obstruction. Alternatively, a foreign body from a lower lobe bronchus may be shifted to an upper lobe bronchus, where anatomic factors complicate its removal.

Complete airway obstruction can be recognized in the conscious child as sudden respiratory distress, followed by an inability to speak or cough. Older children may use the distress signal of choking which is the gesture of clutching the neck between the thumb and index finger. When complete obstruction is identified, prompt delivery of first aid is indicated.

Appropriate management of the child with airway obstruction due to foreign body aspiration is controversial and evolving. In 2000, the American Heart Association, in collaboration with the International Liaison Committee on Resuscitation revised its policy statement on first aid for the child with foreign body obstruction of the airway. Although inspection of the oral cavity for foreign body is still recommended, blind finger sweeps and manipulations to visualize foreign bodies are no longer advocated. Rescuers are advised to perform cardiopulmonary resuscitation for 1 minute prior to activating the Emergency Medical Services System. Since such maneuvers often generate sufficient pressure to expel a foreign body. Back blows and chest thrusts remain the primary therapy for children younger than I year of age, due to the potential for intra-abdominal injury in these children by the abdominal thrust (Heimlich) maneuver. In older children, abdominal thrusts are the mainstay of treatment.

Current recommendations for management of foreign body airway obstruction in infants and children by lay personnel are given below.

In the presence of skilled rescuers and appropriate equipment, laryngoscopy may reveal a foreign body that can be removed to reestablish the airway. If the obstruction is below the level of the vocal folds, ventilation can be temporarily established using an 18-guage needle or

intravenous catheter introduced through the cricothyroid membrane. Urgent tracheotomy can also be performed if surgically trained personnel are present.

First aid for the Choking Child: Recommendations of the American Heart Association and the International Liaison Committee on Resuscitation.

Relief of foreign body airway obstruction in the responsive infant:

1. Infant is held prone with the head slightly lower than the chest, resting on the forearm of the rescuer. The rescuer's forearm is rested on the thigh with the hand supporting the jaw.

2. Five back blows are administered forcefully with the heel of the hand between the infant's should blades.

3. If obstruction is not relived, the infant is turned supine as a unit onto the free forearm with the hand supporting the occiput of the head lower than the trunk.

4. Five rapid chest thrusts are administered over the lower third of the sternum, one finger's breadth below the intermammary line. Chest thrust are delivered at a rate of 1 per second.

5. If the airway remains obstructed, the sequence is repeated until the object is removed or the victim becomes unresponsive.

Relief of foreign body airway obstruction in the responsive child

1. Rescuer stands or kneels behind victim, arms under the victim's axillae, encircling the torso.

2. Rescuer places flat, thumb side of one fist against victim's abdomen in the midline slightly above the navel and well below the tip of the xiphoid process.

3. Rescuer grabs fist with other hand and exerts a series of five quick inward and upward thrusts. The xiphoid process and lower portions of the rib cage are avoided, since force applied to these structures may damage internal organs. Each thrust should be a separate, distinct movement, delivered with the intent to relieve the obstruction.

4. If the airway remains obstructed, the series maybe repeated, or back blows and chest thrusts may be substituted as described for the unresponsive infants. The rescue attempt continues until the foreign body is expelled or the victim becomes unresponsive.

Relief of foreign body airway obstruction in the unresponsive infant or child:

1. Rescuer opens victim's airway with tongue-jaw lift and looks for an object in the pharynx. If the object is visible it is removed with a finger sweep. Blind finger sweep should not be performed.

2. Rescuer opens the airway with a head tilt-chin lift and attempts to provide rescue breaths. If the breaths are not effective, the head is repositioned and ventilation reattempted.

3. If breaths are still not effective:

For infant

a) Rescuer performs sequence of five back blows and five chest thrusts.

b) Steps I through 3a are repeated until the object is dislodged and the airway is patent, or for approximately 1 minute. If the infant remains unresponsive after approximately 1 minute, rescuer activates EMS system.

For Child

a) Rescuer performs sequence of five abdominal thrusts.

b) Steps I through 3a repeated until the object is retrieved or rescuer breathes are effective.

4. Once effective breaths are delivered, rescuer assesses for signs of circulation and provides additional cardiopulmonary resuscitation as needed or places the infant or child in a recover position if he or she demonstrates adequate breathing and signs of circulation.

After Acute Stage

The treatment of choice for foreign bodies in the upper respiratory tract is prompt endoscopic removal under conditions of maximum safety and minimum trauma. Too often, foreign bodies are considered dire emergencies, leading to hasty, inadequate study and poorly prepared, improper attempts at removal. However, unless actual or potential airway obstruction is present, a foreign body is not an acute emergency. The majority of patients with foreign bodies who come to the otolaryngologist have already passed the acute phase. When there is no imminent danger to the patient's life, the problem is approached with complete and thoughtful consideration of the physiologic and mechanical factors involved. The endoscopic removal can be scheduled when trained personnel are available, when instruments have been checked, and when techniques have been tested.

Often, the primary physical may delay referral for endoscopy unless there is strong evidence of a foreign body. Endoscopy, however, is a form of physical examination (inspection) and is, therefore, both a diagnostic and a therapeutic technique. If the history or physical findings are suspicious, endoscopic examination may be indicated to establish the diagnosis and to provide relief of symptoms.

MEDICAL EVALUATION

A thorough medical history and physical examination is necessary prior to endoscopy. Patients with a history of asthma prior to the aspiration are carefully evaluated by specialists in pulmonary medicine or allergy and by the anesthesiologist. A history of poor oral intake or vomiting may suggest a concomitant esophageal foreign body while symptoms of aspiration may herald an associated tracheoesophageal fistula. Further attention is given to other preexisting illnesses and medications the child is taking.

Instruments

The rigid bronchoscope is unquestionably the instrument of choice for working in the tracheobronchial tree. The major drawbacks to the use of flexible instruments are lack of control of the foreign body and inadequate control of the airway. The rigid instruments afford a much greater range of

size and variety of forceps, better exposure of the foreign body, and the ability to shield pointed and sharp foreign body parts within the tube during extraction. The flexible bronchoscope may be of some help in the occasional older child or adult with a foreign body lodged far into the periphery of the lung, or in a patient who is unable to extend the head and neck for any reason.

The Holinger ventilating fiber-illuminated bronchoscopes (Pilling) or Doesel-Huzly bronchoscopes with Hopkins rod-lens telescopes (Karl Storz) are the instruments most commonly employed for foreign body extraction. A 3.5 mm by 25 cm or 4mm by 30cm bronchoscope (Pilling) or a 3.7 mm by 30cm (Karl Storz) is most often used, but, like the laryngoscope, the bronchoscope is selected on the basis of patient age and size. As a general rule, it is wise to use the largest bronchoscope that can be passed without resistance; this permits use of a larger telescope for better visualization and increase the likelihood that the object can be withdrawn through the bronchoscope.

Anesthesia

In cases of severe airway obstruction, foreign bodies are usually located in the larynx or upper trachea. In such cases, the child may be mummified, and the object removed through a laryngoscope placed without

anesthesia. Oxygenation may be supported intraoperatively by insufflations through a nasal catheter.

For most foreign body extractions, however, general anesthesia provides a more controlled setting. Spontaneous ventilation is preferable to apneic technique, since the patient has already demonstrated that he can ventilated himself by generating negative intrathoracic pressure Changing the system to positive-pressure ventilation under apneic conditions may render the patient unable in ventilate owing to obstruction by the foreign body. While spontaneous ventilation technique precludes the use of the rapid sequence induction, no cases of aspiration on induction have been reported.

Preoperative sedation, which can potentially depress the patient's respiratory drive, is avoided. During induction in the operating suite, standard monitoring is initiated, including an electrocardiogram, a precordial stethoscope, a blood pressure cuff, a pulse oximeter, an end-tidal carbon dioxide monitor, and a thermometer. As anticholinergic agent (usually glycopyrrolate) is administered intravenously prior to the procedure to reduce secretions and the risk of bradycardia. Induction of anesthesia is by mask using halothane or sevoflurane and oxygen. Nitrous oxide may be used to facilitate a smooth induction but should be

discontinued prior to the procedure so that the patient remains adequately saturated with oxygen during the foreign body extraction. Following induction the laryngoscope is passed by the endoscopist to ensure that no foreign body is present in the larynx. If the laryngeal inlet is clear, the larynx is sprayed with a solution of 2% lidocaine to desensitize the larynx and reduce the risk of laryngospasm.

The bronchoscope is then inserted, and the tracheobronchial tree is inspected while the patient is ventilated and anesthetized through the bronchoscope side arm. Spontaneous ventilation is maintained through a closed sidearm. The inhaled agent may be changed to isoflurane, supplemented by propofol as needed. Positive-pressure ventilation is avoided, because this tends to drive the foreign body further peripherally. Use of the rod-lens system within the bronchoscope reduces the lumen through which the patient is ventilated and may result in transient desaturation. When this occurs, temporary replacement of the telescope with an eyeglass allows the child to be adequately saturated with oxygen before proceeding. As the anesthesia lightens, an occasional cough may actually help move the begin body toward the bronchoscope.

Endoscopic Technique

Endoscopic extraction of foreign bodies in children is a gentle, delicate procedure. Adequate protection is applied in the eyes and superior alveolar ridge. The laryngoscope is placed atraumatically into the right side of the mouth, with the tongue gently pushed to the left. The tip of the scope is positioned in the vallecula. The bronchoscope is inserted with care taken not to injure the laryngeal structures. One must never force a scope, forceps, or foreign body.

Once the bronchoscope has been advanced into the upper trachea, ventilation through the side arm is established and confirmed by the endoscopist. The tracheobronchial tree is completely inspected, as multiple foreign bodies may be present. Inspection begins with the normal bronchus, and all secretions are removed to ensure optimal respiratory function when the involved side is inspected. When a foreign body is seen, its shape, position, and forceps spaces are assessed. The suction is used to remove secretions from around the foreign body but is inadequate to hold foreign bodies and is not used for removal. The presentation of the foreign body is studied, with special attention to the location of unseen parts such as sharp points, which may be buried deep within the mucosa.

Prior to extraction, the orientation of the object may be modified with the tip of the scope, a technique especially helpful when establishing forceps spaces between the object and lumen walls. When possible, the foreign body is rotated into the sagittal plane, since this is the largest diameter of the laryngeal lumen. One must be cautious not to drive the foreign body further down.

Forceps spaces, the spaces where the blades of the forceps can safely be placed, may be obliterated if granulations are present or if the surrounding mucosa is swollen. If granulations are present proximal to the foreign body, the bronchoscope can be pushed past the granulation, or the granulations can be removed. If bleeding makes manipulation unsafe, topical epinephrine diluted 1: 30,000 or topical oxymetazoline can be applied with a sponge-carrier.

When the foreign body is grasped, an effort is made to place the tips strategically. In grasping globular foreign bodies, the blades must pass beyond the equator of the object to avoid stripping off. Vegetable foreign bodies such as peanuts are grasped lightly to avoid fragmentation. Use of a peanut forceps with light, delicate blades facilitates such gentle handling. Once firmly within the forceps, the object is dislodged and gently withdrawn. The scope is then advanced to the foreign body, and the object

anchored against the tube mouth to protect the grasp. The foreign body, scope, and forceps are then removed as a unit.

Immediately following removal of the foreign body, the laryngoscope is reinserted and a second pass made with the bronchoscope. This procedure ensures that there is no retained foreign body in the airway and allows for reassessment of airway patency in the region previously occupied by the object. Bleeding can be controlled with topical vasoactive agents, granulation tissue can be resected as necessary, and purulent secretions can be more effectively cleared.

Postoperative use of antibiotics is indicated in patients with fever, and when evidence of pneumonia is present. Steroids are not usually necessary unless there has been significant trauma to the airway. In cases in which granulation tissue causes significant narrowing of the airway, steroids may reduce the risk of permanent bronchial stenosis.

Complications

Complication rates in various recent studies range from 0% to 25%. Laryngeal edema and traumatic laryngitis are common sequelae of airway foreign bodies and their removal. Stridor resulting from foreign body extraction can be treated with steroids and racemic epinephrine, as previously described. Persistent pneumonia and atelectasis are most

common following removal of long-standing foreign bodies. Intravenous antibiotics, bronchodilators, and chest physical therapy may be useful for several days postoperatively in such cases. Bronchospasm and postobstructive pulmonary edema, which occur less frequently, may also require aggressive medical management. Further surgical intervention may be required in cases of persistent granulation tissue, laryngotracheal or bronchial stenosis, bronchial hemorrhage, pneumothorax, pneumomediastinum, bronchial fistula, and lung abscess. Fatal complications of airway foreign bodies include complete obstruction of the airway and cardiac arrest induced by prolonged hypoxia. Fortunately, these are exceedingly rare.

Prevention

Avoidance of objects that are easily aspirated or readily lodge in the pediatric airway is the ultimate prevention against all foreign body accidents. However, it is impractical to assume that even the most vigilant parents and caretakers can make all such objects inaccessible to children. Well-child visits are an ideal opportunity to advise parents and caretakers to avoid feeding nuts, popcorn, seeds, and spherical candies to children younger than 4 or 5 years of age. Hot dogs and grapes should be cut into tiny pieces before being fed to young children. Children should also be supervised during playtime, since they may obtain dangerous objects from

a sibling or from a location in the home that has not been childproofed. Balloons are a significant airway risk in children of all ages.

REVIEW OF LITERATURE

FOREIGN BODY ASPIRATION IN CHILDREN

Lima JA, Fischer GB Paediatr Respir Rev. 2002 Dec;3(4):303-7. Foreign body aspiration is more frequent in children younger than 3 years of age, predominantly boys. Food materials are most commonly involved, particularly peanuts, although this could change according to regional feeding habits. The right main bronchus is the site where foreign bodies are most commonly found. Radiographical findings are not diagnostic, but the presence of unilateral obstructive emphysema or atelectasis are important clues. A rigid endoscopy is indicated whenever there is a suggestive history. Routine preventive measures must be taught to caregivers in order to reduce the incidence.

Tracheobronchial foreign bodies. Shivakumar AM, Naik AS, Prashanth KB, Shetty KD, Praveen DS. Indian J Pediatr. 2003 Oct;70(10): 793-7.

In this study done in Bapuji Hospital, JJM Medical College, Davangere during 1997-2000, with a sample size of 165 pediatric cases of suspected foreign body aspiration revealed, children between 1 and 3 years were found to be very vulnerable for aspiration. Majority of children were

boys. Over 70% of the patients had positive history of inhalation. Only 60% of the patients presented immediately, that is within 24 hours after aspiration. Common symptoms were cough and respiratory distress. Decreased air entry was the significant clinical sign. Obstructive emphysema was found in majority of the cases (49.5%). In 65 (61.9%) cases foreign body was lodged in the right main bronchus and majority of these were organic in nature, that is 96 (91.43%). Tracheobronchial foreign bodies should be strongly suspected in pediatric age group who present with a suggestive history, even when physical and radiographic evidence is absent.

Tracheobronchial foreign bodies in children: importance of accurate history and plain chest radiography in delayed presentation. Tokar B, Ozkan R, Ilhan H. Clin Radiol. 2004 Jul;59(7):609-15.

This study was conducted in Turkey with a sample size of 214children. It showed that emphysema was more common in children with foreign body aspiration. Clinical and radiological findings of pneumonia and atelectasis were significantly more common in the groups with delayed diagnosis. The foreign bodies were most frequently of vegetable origin, such as seeds and peanuts. A significant tissue reaction with inflammation was more common in the delayed cases. So to prevent delayed diagnosis, characteristic symptoms, signs and radiological findings of foreign body aspiration

should be checked in all suspected cases. Regardless of radiological findings, bronchoscopy should be considered in patients with an appropriate history.

Foreign body aspiration: what is the outcome? Karakoc F, Karadag B, Akbenlioglu C, Ersu R, Yildizeli B, Yüksel M, Dagli E. Pediatr Pulmonol. 2002 Jul;34(1):30-6.

This study, conducted in Istanbul, Turkey with a sample size of 174 children showed that undiagnosed and retained foreign bodies may result in serious complications such as pneumonia, atelectasis, or bronchiectasis. The risk of long-term complications increased with increasing elapsed time from aspiration to diagnosis; bronchiectasis was a major complication, found in 25% of patients whose diagnosis was delayed by more than 30 days. So it was concluded that timely diagnosis and appropriate treatment of FBA is important to prevent long-term complications in affected children.

The relationship between time of admittance and complications in paediatric tracheobronchial foreign body aspiration. Sirmali M, Türüt H, Kisacik E, Findik G, Kaya S, Taştepe I. Acta Chir Belg. 2005 Nov-Dec;105(6):631-4.

In this study no complications were observed when the patients presented to the hospital within the first 24 hours after the aspiration while fever, purulent sputum, haemoptysis and bronchiectasis were noted in those presented later. Paying medical attention within the first 24 hours after the aspiration of foreign bodies is critical in order to accomplish a complication-free course. Organic foreign bodies and retention period of 30 days and over, constitute major risk factors in the development of bronchiectasis. It is advisable to perform bronchoscopy in the early stages of all suspected cases to avoid serious complications such as bronchiectasis.

Foreign body aspiration: clinical, radiological findings and factors associated with its late removal. Bittencourt PF, Camargos PA, Scheinmann P, de Blic J. Int J Pediatr Otorhinolaryngol. 2006 May;70(5): 879-84. Epub 2005 Nov 8.

The study was carried out to assess the clinical and radiological findings and factors related to delay in definite diagnosis of foreign body aspiration and its removal. The population studied presented a long delay in FB removal, thus demanding actions enhancing parent, physician and health services awareness, aiming at an earlier referral for diagnostic and therapeutic bronchoscopy.

What is the diagnostic value of flexible bronchoscopy in the initial investigation of children with suspected foreign body aspiration? Righini CA, Morel N, Karkas A, Reyt E, Ferretti K, Pin I, Schmerber S. Int J Pediatr Otorhinolaryngol. 2007 Sep;71(9):1383-90. Epub 2007 Jun 18.

The aim of this work is to define the indications of flexible bronchoscopy in the management algorithm of suspected foreign body aspiration. This study was conducted at a tertiary referral University Medical Center in France between January 2002 and July 2006. In case of suspected foreign body aspiration in children, the following management algorithm is suggested: rigid bronchoscopy should be performed solely in case of asphyxia, finding of a radiopaque foreign body, or in the presence foreign body associated with unilaterally decreased breath sounds, localized wheezing and obstructive radiological emphysema, or atelectasis. In all other cases, flexible bronchoscopy should be performed first for diagnostic purposes.

Foreign body aspiration in infants and toddlers: recent trends in British Columbia. Morley RE, Ludemann JP, Moxham JP, Kozak FK, Riding KH. J Otolaryngol. 2004 Feb;33(1):37-41.

This study concluded that infants and toddlers in British Columbia have been aspirating foreign bodies at an alarmingly high rate. Before 2

years of age, children are poorly equipped to grind and swallow hard, crunchy food because they lack second molars and are still adjusting to the descent of the larynx. Caregivers should be informed that children under 3 years of age should never be fed nuts or other hard, crunchy foods. A public awareness campaign is warranted.

STUDY JUSTIFICATION

Foreign body aspiration is a life threatening problem in children. There has been no study on foreign body aspiration in our hospital in the past 10 years.

Previous studies were done in the hospitals with an annual incidence of foreign body aspiration which is much less when compared to our hospital and hence the study in our hospital can be more meaningful.

There is not much clinical data available on the commonest mode of presentation, radiological features and the outcome in foreign body aspiration which the present study would try to find.

AIM

- To examine the demographic pattern of children with foreign body aspiration in institute of child health and hospital for children.
- To evaluate the clinical presentation, investigations, type of foreign body, complications and outcome with respect to the location of foreign body.
- To evaluate the type of foreign body, presentation, complications and outcome of long standing foreign body.
- To develop safety guidelines regarding prevention of aspiration in infants and toddlers.

SUBJECTS AND METHODS

METHODOLOGY

STUDY DESIGN:

Case series study

STUDY PERIOD

November 2005 to June 2007

STUDY PLACE:

Institute of Child Health & Hospital for Children

STUDY POPULATION:

Children admitted in institute of child health and hospital for children

INCLUSION CRITERIA:

1) Patients with suspected foreign body aspiration based on history and clinical features.

2) Patients with accidental finding of foreign body in the lower respiratory tract when investigated for some other purpose.

EXCLUSION CRITERIA

Foreign bodies in upper airway and in gastrointestinal tract

MANEUVER:

Patients with suspected foreign body aspiration based on history, clinical examination and radiological evidence were taken up for the study. A detailed history and a thorough clinical examination was done in all patients. The following data was collected: sex, age, working status of the mother, number of siblings in the family, duration of illness and the availability of a definitive history of foreign body aspiration. The patients will then be subjected to radiological investigations. Complications due to the foreign body at the time of presentation were noted. Patients with definite evidence of foreign body aspiration were taken up for rigid bronchoscopy directly. Patients with doubtful evidence were subjected to flexible fiber optic bronchoscopy and then taken up for rigid bronchoscopy. Location and nature of foreign body were noted. The patients were followed up for the complications due to the foreign body and due to the procedures involved. Patients with incidental finding of foreign body in airway were also included.

STATISTICAL ANALYSIS

P value, odds ratio and other parameters were computed with the help of a statistician using Pearson Chi-square test to find out the association between the complications due to the foreign body and their risk factors.

RESULTS

Of the 162 children who were suspected to have foreign body aspiration during this period, 101 children required flexible fiber optic bronchoscopy for confirming the diagnosis before doing rigid bronchoscopy. In the remaining 61 cases rigid bronchoscopy was done directly.(Table-1)

Of these a total of 136 cases were found to have foreign body in the tracheobronchial tree. In this flexible fiberoptic bronchoscopy was done in 83 cases before rigid bronchoscopy. In the remaining 53 cases rigid bronchoscopy was done directly.

Table-1:
Procedures done to diagnose and remove foreign bodies in airway

Procedure	*Foreign body present*	*Foreign body absent*	*Total*
Flexible fiber optic bronchoscopy(FFBS)	83*	18	101
Rigid bronchoscopy done directly with out FFBS	53	8	61
	136	26	162

* *In all these cases rigid bronchoscopy was done after FFBS to remove the foreign bodies*

Table-2
Age of children with foreign body aspiration

Age (years)	*No. of patients*		*Total*	*Percentage (%)*
	Male	*female*		
< 1	11	5	16	11.76
1-2	31	23	54	39.71
2-3	36	11	47	34.53
>3	19	0	19	14.00
Total	97	39	136	100.00

Table-3
Sex distribution of children with foreign body aspiration

Sex	***No. of patients***	***Percentage (%)***
Male	97	71.32
Female	39	28.68
Total	136	100

The age group of the children in our study ranged from six months to 12 years, with 86.0% being below the age of three years (Table-2). Of the 136 children 97 were male and 39 were female with the male to female ratio of 2.4:1(Table-3). In our study we found that 69.12% (n=94) of the children were living in joint families with many siblings. Most of the children (62.5%, n=85) had working mothers, in which case the care taker is someone else other than the mother.

Table-4:
Duration of symptoms in children with definite history of foreign body aspiration

Symptom duration	*No. of patients*	*Percentage (%)*
< 1day	32	45.71
2-14 days	29	41.43
>14 days	9	12.86
Total	70	100.00

A positive history of foreign body aspiration was present in 51.4% (n=70) patients. The duration between the time of aspiration and presentation varied from few hours to one year. Of the patients with a positive history of foreign body aspiration, only 45.71%(n=32) presented with in 24 hours. Twenty nine patients(41.43%) presented from 1 to 14 days of foreign body aspiration. Nine patients(12.86%) presented after 14 days of treatment with drugs(Table-4).

Table-5:
Clinical Features of Patients with Foreign Body Aspiration

Features	*Number N = 136*	*Percentage (%)*
Acute Choking episode	70	51.47%
Persistent cough	81	59.56%
Respiratory distress	74	54.41%
Stridor	11	8.09%
Decreased air entry	84	61.76%
Wheezing	22	16.18%
Fever	28	20.59%

Our study showed that the most common symptom was cough in 59.56%(n=81)of cases, followed by respiratory distress in 54.41%(n=74)of

cases. The most common sign was unilateral decrease in air entry present in 61.76%(n=84) of cases(Table-5).

Table-6:
Radiological signs in children with foreign body aspiration

Radiological sign	*No. of patients*	*Percentage (%)*
Obstructive emphysema	66	48.53
Pneumonia	27	19.85
Collapse	18	13.23
Bronchiectasis	3	2.21
Radio opaque foreign bodies	3	2.21
Normal	19	13.97
Total	136	100.00

Radiological features were present in 86.03%(n=117) of cases due to foreign bodies. Obstructive emphysema was the commonest radiological feature in 48.53%(n=66) cases. Pneumonitis was present in 19.85%(n=27) cases, 13.23%(n=18) cases had collapse and 3(2.21%) cases had bronchiectatic changes. Three(2.21%) cases had radioopaque foreign bodies. Chest X-ray was normal in 13.97%(n=19) of cases(Table-6).

Fluoroscopy was done in 11 patients of which 6 were positive. Since in our institution we had easy access to flexible fiberoptic bronchoscopy

doubtful cases were directly taken up for flexible fiberoptic bronchoscopy than fluoroscopy.

Flexible fiberoptic bronchoscopy was done in 61.03%(n=83) cases. In cases with foreign body aspiration 22.89%(n=19) had granulation tissue. Repeat flexible fiberoptic bronchoscopy was required in 22 cases. All the cases with granulation tissue showed healing of the granulation tissue on follow up except one case which developed bronchial stenosis. Three cases had remnants of foreign bodies.

Rigid bronchoscopy was done in all the cases to remove foreign bodies. Three cases required repeat rigid bronchoscopy to remove the remnants. In one case foreign body could not be removed as there was a proximal stenosis.

Table-7:
Location of foreign body in the tracheobronchial tree

Site	*No. of patients*	*Percentage (%)*
Right bronchus	68	50.00
Left bronchus	52	38.24
Trachea	8	5.88
Subglottis	5	3.67
Bilateral	2	1.47
Wandering foreign body	1	0.74
Total	136	100

Foreign bodies were found in the right side in 50%(n=68) cases and in the left side in 38.24%(n=52) cases. Eight cases(5.88%) had foreign body in the trachea and five cases(3.67%) had foreign body in the subglottis. Two cases(1.47%) had foreign bodies on both sides. In one case it was noticed that the foreign body was migrating on either side with varying findings in radiological images(Table-7).

Table-8:
Types of airway foreign bodies in children.

Foreign body	*No. of patients*	*Percentage (%)*

Organic	129	94.85
Peanut	88	64.71
Coconut	10	7.35
Arecanut	6	4.41
Tamarind seed	6	4.41
Custard apple seed	5	3.68
Other Seeds	10	7.35
Bengal gram	2	1.47
Peanut hood	1	0.73
Coconut flower	1	0.73
Inorganic	7	5.15
Plastic object	3	2.21
Metallic object	3	2.21
Tablet	1	0.73
Total	136	100.00

In our study vegetable foreign body was found to be the commonest, comprising 94.85%(n=129) cases. Among the vegetable foreign body peanuts were the commonest and was present in 64.71%(n=88) cases followed by coconuts in 7.35%(n=10) cases. Other foreign bodies like arecanut, tamarind seed, Bengal gram, grass weed, coconut flower were also seen. Seven cases(5.15%) had inorganic foreign bodies, which were mostly plastic objects seen in toys(Table-8).

Table-9:
Complications due to Foreign Body *aspiration*

Complications	**No. of patients**	**Percentage (%)**
Pneumonia	27	55.10%
Collapse consolidation	18	36.74%
Late complications on follow up		
Bronchiectasis	3	6.12%
Bronchial stenosis	1	2.04%
TOTAL	49	49

Thirty six percent (n=49) of the patients developed complications due to foreign bodies. Pneumonia was the most common complication in 19.85%(n=27) of cases followed by collapse consolidation in 13.23% (n=18) of cases. Three cases developed bronchiectasis. One child had developed bronchial stenosis even at the time of presentation(Table-9).

Table-10:
Complications due to the procedure

Complications	
Pneumothorax/ pneumomediastinum	3*
Hypoxic encephalopathy	1
TOTAL	4

* *Of these 2 children died*

Four cases developed complications due to rigid bronchoscopy. Three cases developed pneumothorax and pneumomediastinum. One case developed hypoxic encephalopathy during rigid bronchoscopy. Two children died after removal of their foreign bodies due to complications like pneumothorax and pneumomediastinum (Table-10).

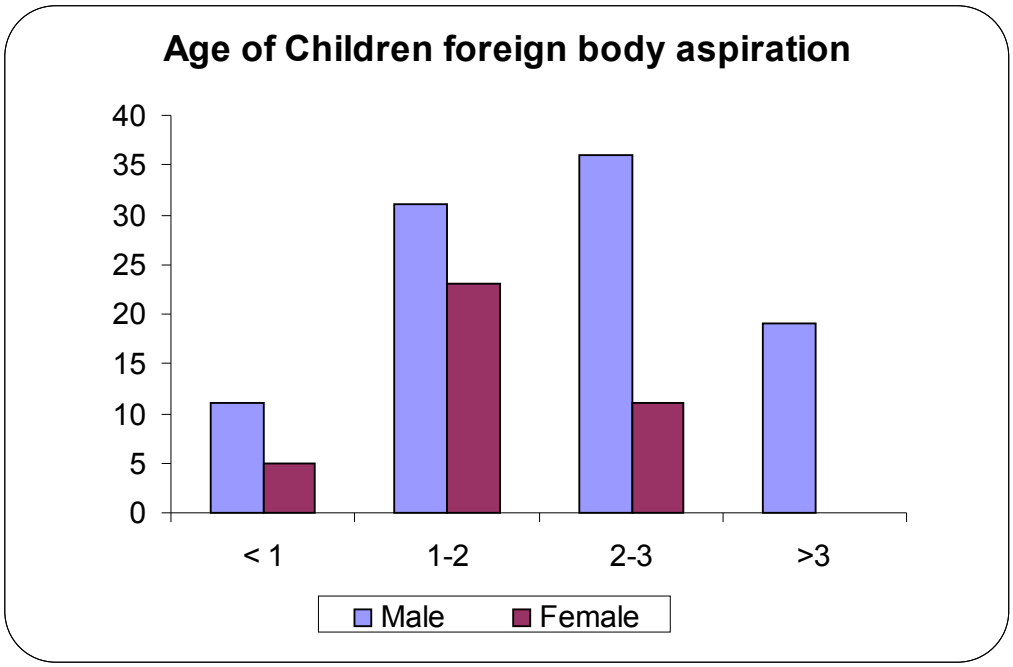
On follow up all the cases with pneumonia resolved and the cases with bronchiectasis continued to have the findings and were treated with physiotherapy. The cases with retained foreign body continues to have it distal to the stenosis and is on regular follow up.

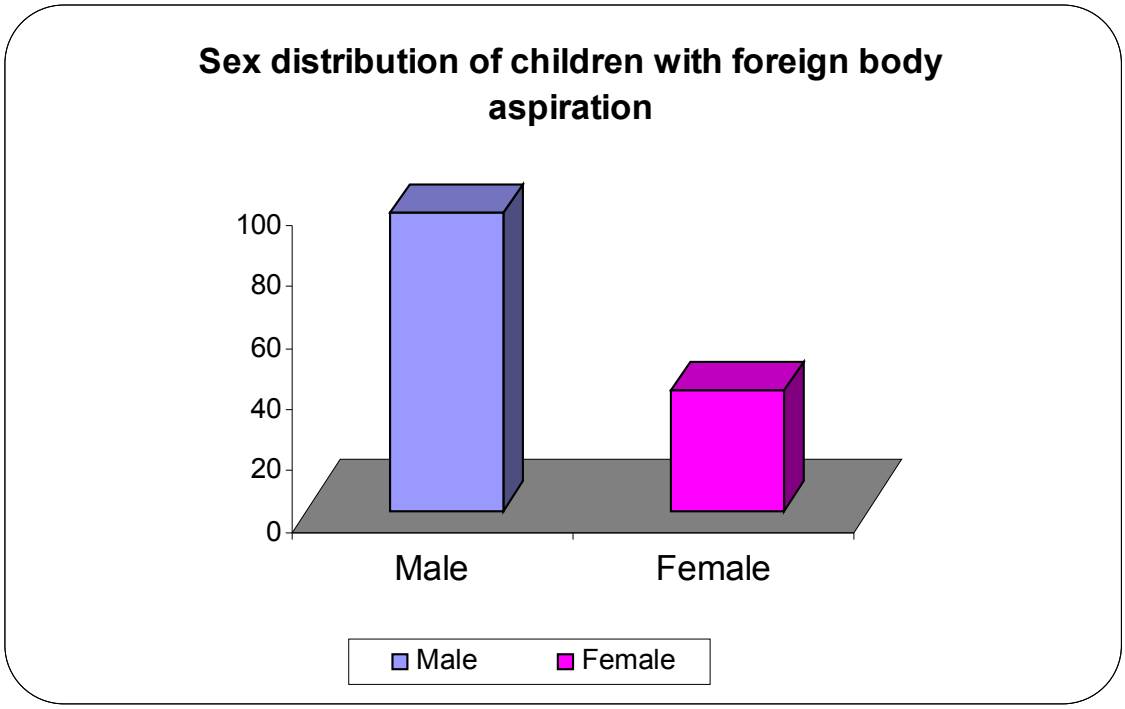
Table-11 :
Statistical analysis of children with complications due to foreign body and their risk factors

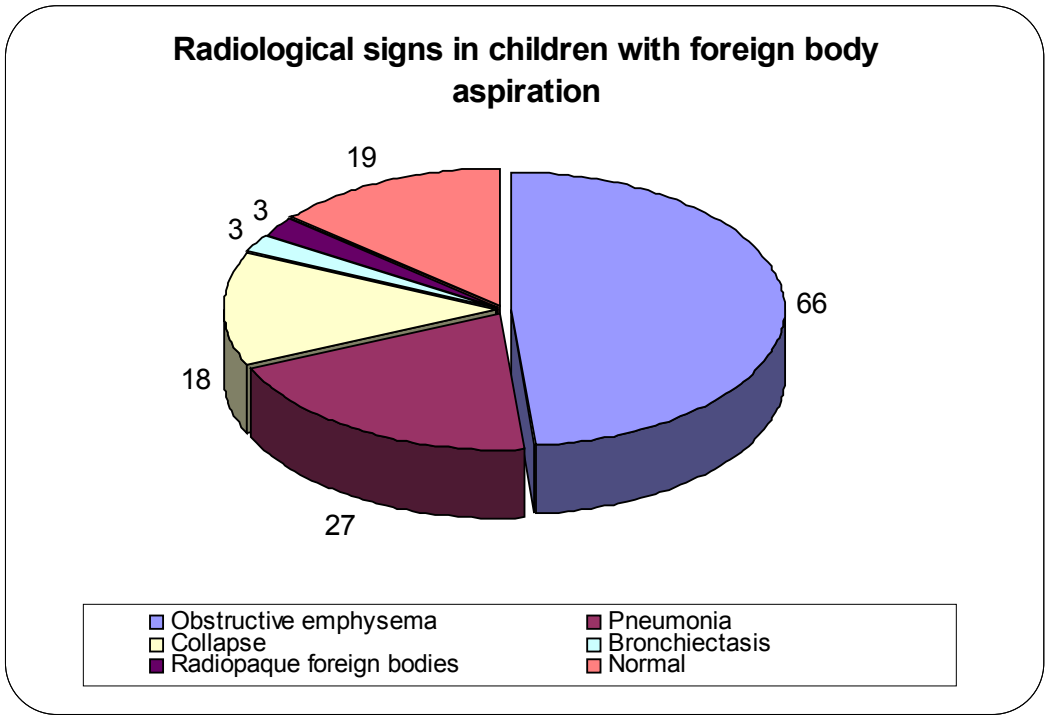
Risk factors		*Complications*		*Odds ratio*	*95% confidence limits*	*P value*
		Present n(%)	*Absent n(%)*			
Duration	>14days	5 (55.6)	4 (44.4)	4.19	0.99, 17.78	0.04
	≤ 14days	14(23.0)	47(77.0)			
Age	≤3years	38 (32.5)	79 (67.5)	0.349	0.13, 0.941	0.032
	> 3years	11(57.9)	8 (42.1)			
Site of FB	Right	23(33.82)	45(66.18)	0.754	0.349, 1.56	0.425
	Left	21 (40.4)	31 (59.6)			
Nature of FB	Organic	46 (35.7)	83 (64.3)	0.739	0.158, 3.446	0.699
	Inorganic	3 (42.9)	4 (57.1)			

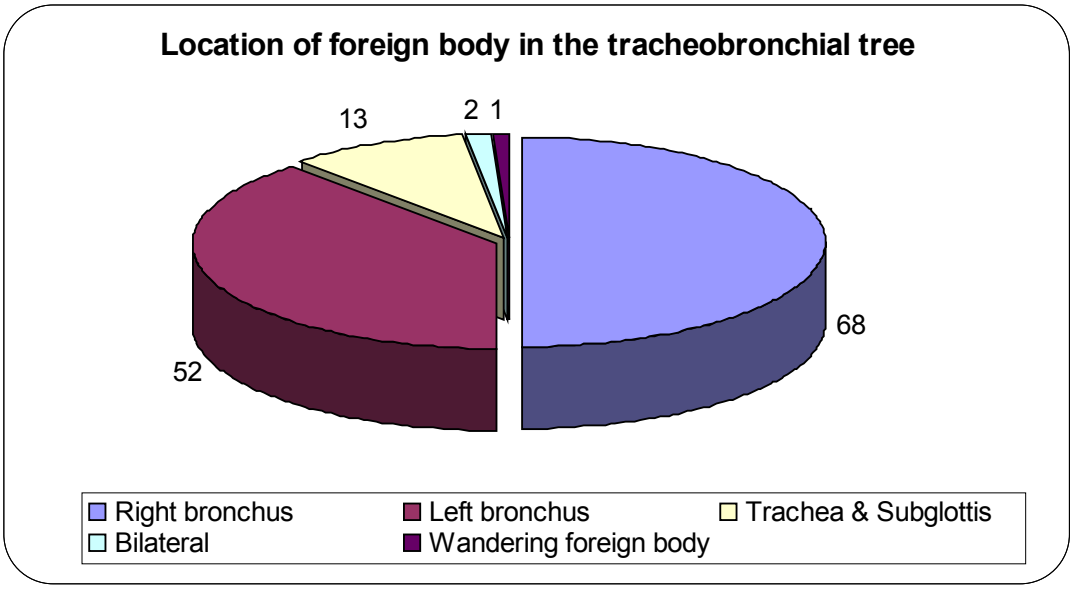
Statistical analysis showed that there was a significant correlation between, retained foreign body in the bronchus of more than 14 days duration and complications due to the foreign body(p value= 0.04). It was also found that there was a significant correlation between the age and the complication (p=0.032). Children of less than 3 years of age were more prone to complications than children of older age group(Table-11).

There was no significant correlation between the nature of foreign body or the site of foreign body and the complications. The vegetable foreign bodies were commonly found in children of younger age group and inorganic foreign bodies were common in older children.


Age of Children foreign body aspiration
40
35
30
25
20
15
10
5
0
< 1
1-2
2-3
>3
Male
Female


Sex distribution of children with foreign body aspiration
100
80
60
40
20
0
Male
Female
Male
Female


Radiological signs in children with foreign body aspiration
19
3
3
66
18
27
Obstructive emphysema
Pneumonia
Collapse
Bronchiectasis
Radiopaque foreign bodies
Normal


Location of foreign body in the tracheobronchial tree
13
2
1
68
52
Right bronchus
Left bronchus
Trachea & Subglottis
Bilateral
Wandering foreign body

DISCUSSION

Tracheobronchial foreign body aspiration is an important life threatening condition in young children. Our study showed that children, less than 3years of age were most commonly affected, as like in other studies(1,2,3). The younger group is more vulnerable because of the lack of adequate dentition i.e. they do not have premolars or molars and cannot grind smaller inhalable pieces effectively(4). Additionally, among children of this age, introducing objects into their mouths is their way of exploring the world.

Our study showed a male predominance, which is in agreement with many other studies. (5,6,7)

In our series, only 51.47% of the cases had a definitive history of foreign body aspiration. There may be a symptomless period after first paroxysm, which may vary in duration from few days to even months. However, subsequent wheezing, cough, choking and persistent pneumonitis point towards a possible foreign body aspiration.

In our study 12.9% of the patients even with history of foreign body aspiration were referred after 2 weeks. These patients treated with antibiotics, bronchodilators and nebulisations before referral.

One case even with a history of foreign body aspiration was treated as asthma and was referred after 6 months. One case with a plastic whistle presented after one year.

When a foreign body is inhaled into the distal bronchial system without causing an acute obstruction, it may remain silent for a while depending on its nature. Organic materials cause a more severe mucosal inflammation, and granulation tissue may develop in a few hours. Furthermore, objects such as beans, seeds, and corn can absorb water, and with subsequent swelling, partial obstruction can change to total obstruction. On the other hand, patients who have inhaled small inorganic materials usually remain asymptomatic for a longer period of time unless total obstruction of a distal airway is caused.

The clinical signs and symptoms were present in most of the patients. Cough was the most common symptom followed by respiratory distress. Unilateral decrease in air entry was the most common sign. Some of the cases presented only with the clinical features of foreign body without any history or radiological features. So a high index of suspicion is necessary to diagnose foreign body aspiration.

Sivakumar et al.(2) in their study done in 165 children showed that children between 1 to 3 years were commonly involved, with majority of

them being boys. Common symptoms were cough and respiratory distress. Decreased air entry was the significant clinical sign. Obstructive emphysema was found in majority of the cases (49.5%).

Our study showed positive radiological findings in 86.03% of cases due to foreign bodies. In other studies it was found to be 80%(8,9,10). Obstructive emphysema was the most common radiological sign present in 48.53% . This is in agreement with various studies(5,8,9,10,11). Other common radiological features were persistent pneumonitis, collapse consolidation and bronchiectatic changes. Radiology was normal in 13.97%. Three cases had radioopaque foreign bodies. Three cases had pneumothorax, pneumomediastinum after removal of foreign bodies.

Sirmali M et al (10) in their study showed that pathology could be detected radiographically in 80.3% of the cases and in 19.7% radiology was normal.

In patients with persistent respiratory symptoms and in patients with doubtful foreign body aspiration based on history, clinical examination and radiological features were subjected to flexible fiber optic bronchoscopy with which could establish the diagnosis and localise the site of foreign body accurately, that will help in removal later(12). Even just localisation of the foreign body during the initial fiberoptic bronchoscopy allows

subsequent rigid bronchoscopy to be shorter in duration with fewer complications(13). With delay in removal, changes like granulation tissues, gush of purulent fluid, inflammatory changes and bronchiectatic changes were seen. In patients with such complications, repeat flexible fiberoptic bronchoscopy was done on follow up to look for any remnants.

Rigid bronchoscopy usually gives good results and it is the method of choice for removal of foreign bodies(15,20). The patients with definite evidence of foreign body aspiration were taken up for emergency rigid bronchoscopy. In most of the cases foreign bodies were removed intoto and in the rest with long standing foreign bodies were removed in pieces. Only three cases required repeat rigid bronchoscopy for removal of remnants of foreign body.

In 50.74% of the children foreign bodies were found in the right side of the Tracheobronchial tree and in the left in 38.24%. In most of the adult studies it was shown that 70% of the foreign bodies were in the right side and 30% in the left(16,17,18). This is explained by the anatomical features of the right main bronchus, i.e. it is not as wide and the angulation of left main bronchus is not as acute as in adults.

Van Looij MA et al. in their study concluded that aspirated foreign bodies are equally distributed between the left and right main bronchus in children(16).

Although a wide variety of foreign bodies were removed, we observed that the peanut is the commonest foreign body, which is the same observation made by almost all the previous studies(1,6,7), especially vegetable foreign bodies. The propensity of finding a peanut in airways of children is probably due to its availability and affordability as compared to other nuts in India. The inorganic foreign bodies were more common in older children and were mostly plastic objects used in toys.

Thirty six percent of the patients in our study had complications due to foreign bodies. Patients who presented late were more prone to complications than who presented early. Persistent pneumonitis was the most common complication due to foreign bodies. The most common late complication found on follow-up was bronchiectasis(19). One case had bronchial stenosis with a foreign body distal to the stenosis and is on regular follow up.

Three cases developed pneumothorax and pneumomediastinum following removal of foreign bodies.

One case had open safety pin in the bronchus. While removing, the head of the safety pin loosened and got retained in the bronchus. As the patient developed pneumothorax the procedure was abandoned. The child developed hypoxic encephalopathy subsequently. But on follow up the head of the safety pin was found to be coughed out and hypoxic encephalopathy sequela was present.

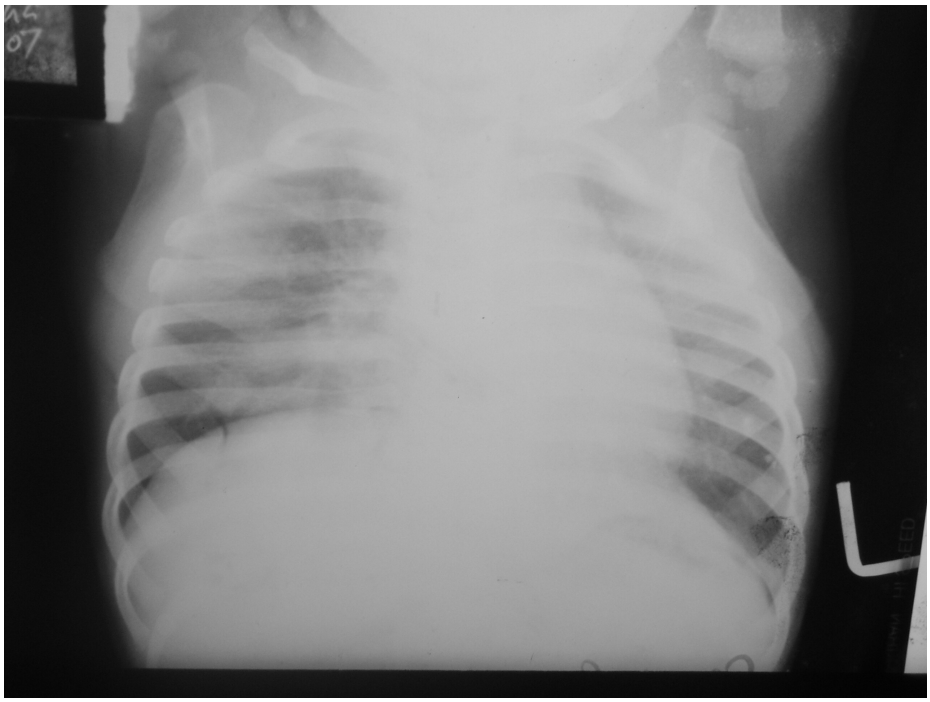
There were two deaths in our study. Both the cases died after removal of their foreign bodies due to complications like pneumothorax and pneumomediastinum.

There was a statistically significant correlation between the age and duration of foreign body aspiration. The children with younger age were more prone to complication than children of older age. In the same way children who were misdiagnosed and presented late were more to complications than the children who presented early(20).

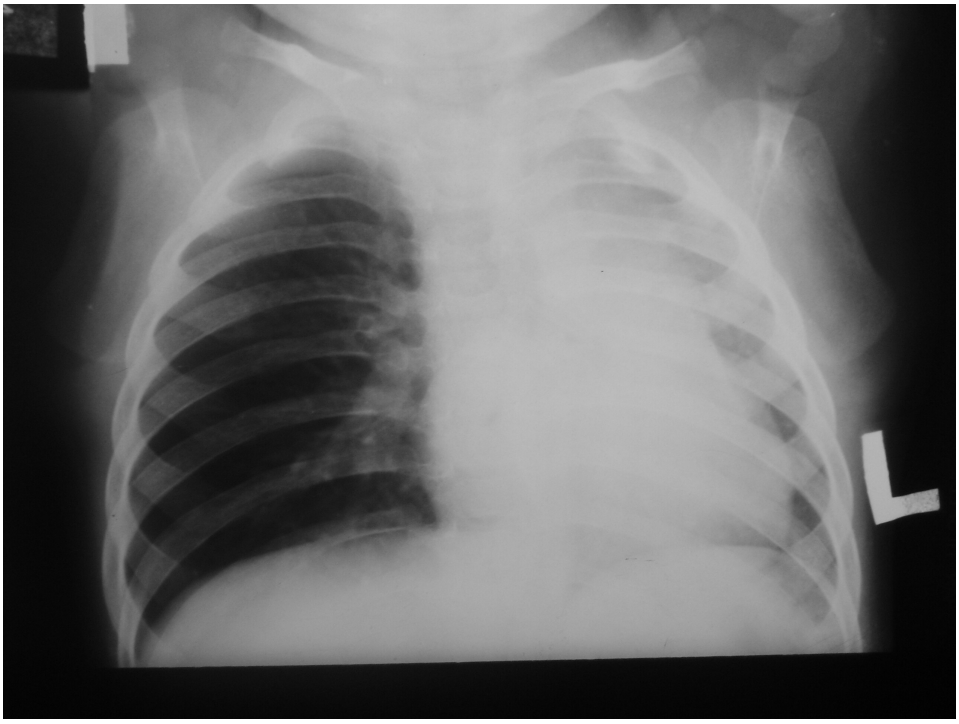
When diagnosis is delayed, complications of a retained foreign body such as unresolving pneumonia, bronchial stenosis, and bronchiectasis may necessitate a surgical resection.

COLLAPSE LEFT LUNG

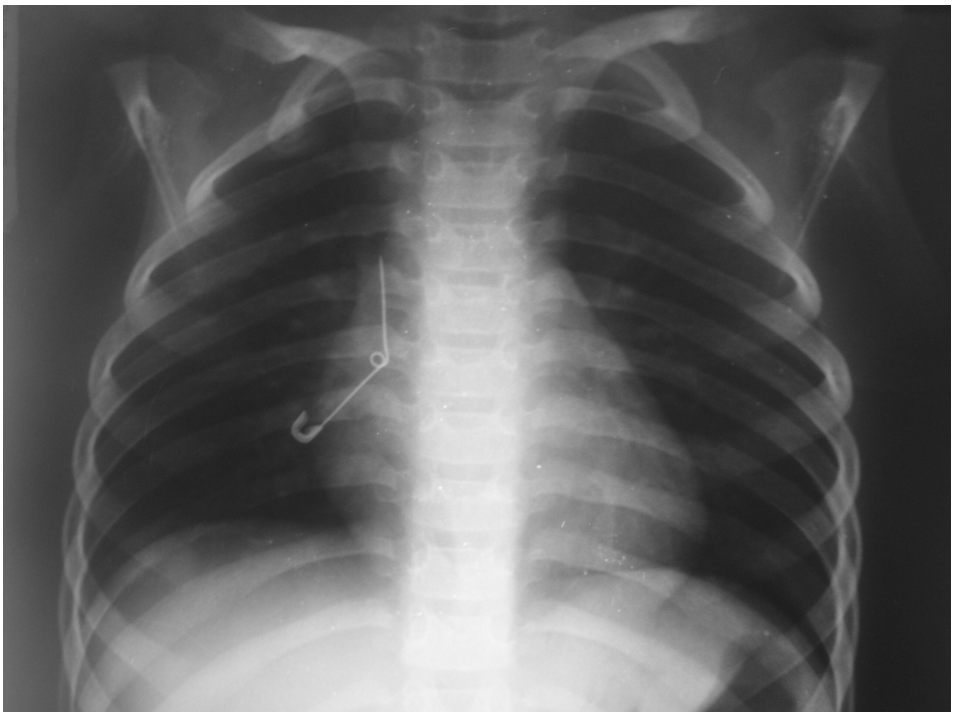
PNEUMONITIS RIGHT LOWER LOBE



OBSTRUCTIVE EMPHYSEMA RIGHT LUNG



RADIO OPAQUE FOREIGN BODY



FEW COMMON FOREIGN BODIES

GROUNDNUT

COCONUT

CUSTARD APPLE SEED

SAFETY PIN

PLUG PIN

CONCLUSION

- Foreign body aspiration is common in children less than 3 years of age
- Foreign body aspiration is more common in male children
- A definite history of foreign body aspiration is present only in 51% of cases
- Persistent cough is the common symptom
- Unilateral decreased air entry is the most common sign
- Obstructive emphysema is the most common radiological sign
- Persistent pneumonitis is the most common complication
- Flexible fiberoptic bronchoscopy is a very safe diagnostic modality which is helpful in making accurate diagnosis
- Rigid bronchoscopy is the method of choice for removal of foreign body
- Peanut was the most common foreign body

- The incidence of foreign body in left bronchus is almost as common as in right bronchus in children unlike adults
- Children less than 3 years are more prone to complications due to foreign body aspiration
- Retained foreign body in the bronchus of more than 14 days duration is significantly associated with complications

RECOMMENDATIONS

It is important for the clinician to have a high index of suspicion, especially in patients with sudden appearance of a respiratory distress without a previous history of asthma, especially with unilateral decrease in air entry.

Early intervention gives better results and reduces the risk of further complications due to foreign bodies.

Education is the best preventive measure for decreasing the incidence of this problem. The parents should be educated to abstain from feeding nuts and seeds to young children who do not have premolars or molars and cannot grind smaller inhalable pieces effectively. They can be given in powdered form. It is important to avoid loose small objects on the floor or within reach of children.

The aspiration of inorganic foreign bodies is less frequent and requires additional preventive measures, since it may occur in older children. First, it is important to inspect the settings where children spend most of their time Toys should be selected according to the age of children; they should be given toys that do not have small, removable parts.

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PROFORMA

NAME

FATHER'S NAME

MOTHER'S NAME

AGE/SEX

IP No.

ADDRESS

TELEPHONE NO

SOCIOECONOMIC STATUS

EDUCATIONAL STATUS

WORKING STATUS OF MOTHER

CARE TAKER OF THE CHILD

JOINT FAMILY/ NUCLEAR FAMILY

NO. OF SIBLINGS

HISTORY

H/O Foreign body aspiration

Time of aspiration

Time of presentation

Child attended/unattended

Person who witnessed

Presenting symptom

Presence of complications

CLINICAL EXAMINATION

RADIOLOGICAL FEATURES

FLUOROSCOPIC FINDINGS

FIBREOPTIC BRONCHOSCOPIC FEATURE

RIGID BRONCHOSCOPY DONE ON

FOREIGN BODY REMOVED

Nature of foreign body

Site of foreign body

COMPLICATIONS

Due to foreign body

Due to the procedure

REPEAT X-RAY

OUTCOME

FOLLOW UP

3 months

6 months

1 year