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Clinical Presentation and Radiological Correlation of Respiratory Foreign Bodies in Children

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ABSTRACT

Foreign body related aspiration continues to be a major cause of morbidity and death in childhood, especially in the age group 5 years. Although the magnitude of disaster is notifiable, it presents a situation to the pediatricians especially in the most socio-economically under privileged rural Indian areas, who are also illiterates in nature. This work has the aims to estimate the incidence of FB obstruction of nasal and/or oropharyngeal and lower airways in children, hypothesize on the clinical symptoms and symptomatic presentation of pulmonary FB aspiration, identify the highest risk age group and characterize radiological features of FB aspiration and correlate these features to presentation in clinic. Retrospective and prospective case series in 110 pediatric patients (12 years of age) with airway foreign body obstruction. The results showed that 70% of children presented with foreign bodies in the nose, with the majority being younger than 4 years of age and male. Unilateral nasal blockage, nasal discharge and epistaxis were the most common symptom. Vegetable material alimentary foreign bodies (groundnuts) were the most encountered material of foreign body in case of aspirational blockage. The paper emphasizes the necessity of early detection and early management of FB aspiration, which potentiates into irreversible and latent pulmonary damage, that is usually overlooked. It also points out the need to train parents about risk factors and protective measures regarding FB aspiration that can be prevented. The outcomes of the present study could be further employed to design interventions /strategies of how to prevent FBA in the pediatric population.

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Key Words
Clinical presentation, radiological correlation, respiratory foreign bodies

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INTRODUCTION

Upper airway obstruction and aspiration of foreign bodies remain significant causes of childhood morbidity and mortality, presenting ongoing challenges for pediatricians[1]. These incidents are not recent phenomena., in 1663, London physician Stephan Bradwell noted, "Of things that endanger stopping of breath in swallowing, some are sharp and some blunt. I have heard of a child in Wood Street strangled with a grape[2]." These events are most common in children aged between 6 months and 5 years, especially those under 2 years of age[3]. Contributing factors include toddlers' natural curiosity, which leads them to explore their environment by putting objects into their mouths, immature swallowing coordination, inadequate detrition, physical activity during feeding and poor food control. Such issues are especially prevalent in rural areas of India among lower socio-economic groups and uneducated populations. Foreign body aspiration is a potentially life-threatening condition and can lead to chronic lung damage if not managed appropriately. The symptoms and signs of foreign body aspiration depend on the nature, size, location and duration of the foreign body's presence in the tracheobronchial tree. A large foreign body obstructing the upper airway may lead to sudden death, whereas a smaller foreign body lodged in the bronchial tree may present with less severe symptoms. Timely diagnosis and management are crucial for successful treatment. Bronchoscopy remains the gold standard for definitive diagnosis and advancements in anesthetic and endoscopic techniques, coupled with a deeper understanding of the problem among pediatricians, have made the management of foreign body aspiration significantly safer and more effective. These improvements have reduced mortality rates from 50% in 1977 to <1% today[4]. Early detection and skilled management are essential for minimizing mortality and morbidity. Moreover, foreign body aspiration is a preventable accident and efforts should focus on educating parents about its risks and preventive measures.

Anatomy, Physiology and Pathophysiology: To understand the signs and symptoms caused by foreign bodies in the respiratory tract, a basic understanding of relevant anatomy, physiology and pathophysiology is essential.

Anatomy: The respiratory tract is divided into two main sections:

- **Upper Airway:** Includes the nose, middle ear, paranasal sinuses, and pharynx.
- **Lower Airway:** Comprises the laryngo trachea bronchial tree.

Upper Airway: The nose, the focus of this study, consists of a bony and cartilaginous framework, covered by skin and fibro-fatty tissue. The nasal cavity is divided into right and left halves by the nasal septum and connects to several structures:

- The anterior cranial fossa through the cribriform plate of the ethmoid bone.
- The nasopharynx and middle ear via the pharyngotympanic tube.
- The paranasal sinuses.
- The lacrimal apparatus and conjunctiva.

Lower Airway:

- **Larynx:** The larynx consists of several components, including the hyoid, epiglottis, thyroid cartilage, cricoid and arytenoids. Compared to adults, the larynx in children is relatively narrow. The cricoid cartilage connects to the thyroid cartilage and the arytenoids via the cricothyroid ligament. The larynx is divided into three compartments:
- The supraglottic compartment (above the false vocal cords).
- The glottic compartment (between the false and true vocal cords).
- The infraglottic compartment (between the true vocal cords and the first tracheal ring).
- The laryngeal muscles control glottis opening during inspiration, closure during swallowing and modulation of tone during phonation.
- **Tracheobronchial Tree:** The trachea is a cartilaginous and membranous tube extending from the lower end of the cricoid cartilage at the level of the 6th cervical vertebra to the upper border of the 5th thoracic vertebra. It is D-shaped, with incomplete cartilage rings anteriorly and laterally and a membranous wall posteriorly. In children, the trachea is smaller, softer and closer to the skin at the cricoid, becoming deeper as it approaches the thoracic inlet. The bronchial tree begins at the bifurcation of the trachea at the carina, dividing into lobar and segmental bronchi and eventually into alveolar ducts and alveoli. The right bronchus is shorter, wider and has a smaller angle of origin than the left bronchus, which explains why foreign bodies are more likely to enter the right bronchus[5].

In children under 5 years, airway resistance is higher than in adults and foreign bodies more easily obstruct the conducting airways.

Physiology: The nasal airways filter larger particles (10-15 microns) through coarse hair at the nostrils, and most inhaled particles larger than 5 microns are impacted on the nasal mucosa. The nasal cavity also warms and humidifies inspired air. The larynx serves

three roles: it acts as an open valve during respiration, a partially closed valve modulating phonation and a closed valve protecting the trachea and bronchi during swallowing. The cilia of the tracheobronchial tree beat at around 1000 beats per minute, moving the mucous blanket towards the pharynx, thus trapping particles and preventing them from reaching the alveoli. Coughing is the primary mechanism for clearing large debris from the respiratory tract, facilitated by irritant receptors in the bronchial tree, which stimulate the brainstem to initiate a forced expiration.

Pathophysiology: Foreign body aspiration in children is a preventable accident that can involve solid or liquid foreign bodies from animal, vegetable, or mineral sources[6].

- **Upper Airway Foreign Bodies:** In the nose, foreign bodies lead to inflammation and infection, producing mucopurulent discharge and epistaxis, usually unilateral. If the foreign body remains for a prolonged period, it may lead to granulation tissue formation, mucosal ulceration and occasionally necrosis of bone and cartilage. Sharp foreign bodies may penetrate into the sinuses, causing sinusitis. Over time, inert foreign bodies may become coated with calcium, magnesium phosphate and carbonate, forming a rhinolith.
- **Lower Airway Foreign Bodies:** When a foreign body enters the laryngotracheobronchial tree, it causes acute symptoms such as coughing, choking, broncho spasm and cyanosis. After the acute episode, symptoms may subside, but local and systemic complications can develop, depending on the foreign body's size, type and the duration of its presence. Foreign body obstruction in the bronchus can occur in several ways:
- **Bypass Valve:** Small foreign bodies or those with adequate space around them allow air to pass during inspiration and expiration, resulting in partial obstruction.
- **Check Valve:** A larger foreign body blocks the bronchus during expiration, causing air trapping and obstructive emphysema.
- **Stop Valve:** A foreign body completely occludes the bronchus, leading to atelectasis, secondary infection, or lung abscess.
- **Ball Valve:** A foreign body that moves with expiration and reimpacts during inspiration, leading to early atelectasis[7].

Vegetative foreign bodies, such as peanuts and seeds, can cause severe bronchitis due to the presence of fatty acids, which absorb water and cause rapid bronchial occlusion and collapse. Non-vegetative foreign bodies, in contrast, are typically better tolerated, especially if they are flat or hollow, allowing for air entry and causing minimal trauma.

Aims and Objectives:

- To investigate the occurrence of foreign body obstruction in the upper airway (nasal and oropharyngeal) and lower airway in children.
- To examine the clinical presentation and manifestations associated with respiratory foreign body aspiration.
- To identify the most commonly affected age group in cases of foreign body aspiration.
- To analyze the radiological features of foreign body aspiration and their correlation with clinical findings.

MATERIALS AND METHODS

In the present study 110 children aged <12 years with foreign bodies in their respiratory tracts were studied, investigated and managed. These patients were selected from those attending pediatric and ENT outpatient department and casualty of Chirantan Hospital, Dhulia, giving history suggestive of foreign body in the respiratory tract or presenting with clinical features of the same. After carrying out appropriate investigations and procedures those who turned out to be negative for foreign body were excluded from this study out given in a below two years with period special from 2007-2009. This was retrospective and prospective study which was carried reference to history clinical examination, investigations, management and complications was filled in.

RESULTS AND DISCUSSIONS

Nasal Foreign Bodies:

Table 1: Site of Foreign Body

Site	no. Of Cases
Nose	70
Laryngotracheobronchial	40
Total	110

Table 2: Age Incidence

Age in years	no.of cases	Percentage
0-1	14	20
1-4	49	70
4-7	6	8
>7	1	2
Total	70	100

Table 3: Gender Incidence

Sex	No. of cases	Percentage
Male	42	60
Female	28	40
Total	70	100

Table 4. Symptoms and Signs

Symptoms and signs	no.of cases	Percentage
Nasal Obstruction	60	86
Foregn body visualised	52	75
Pain	36	52
Discharge	36	52
Epistaxis	31	44
Sneeze	28	40
Congested mucosa	21	30
No symptoms	10	14

Laryngotracheobronchial Foreign Bodies:

Table 5: Age Incidence

AGE IN YEARS	NO. OF CASES	percentage
0-1 years	8	20
1-3 Years	20	50
3-4 years	6	15
4-12 Years	6	15
Total	40	100

Table 6: Sex Incidence

SEX	NO. OF CASES	Percentage
Male	28	70
Female	12	30
Total	40	100

Table 7: History of Foreign Body Aspiration

History	NO.OF CASES	Percentage
Positive	26	64
Negative	14	36
Total	40	100

Table 8: Presenting Symptoms

Symptoms	no. Of cases		
	laryngo tracheal	Bronchial	Total
Cough	6	34	40
Breathlessness	5	23	28
Fever	1	26	27
Choking	4	14	18
Spontaneous expulsion	1	-	1
Repeated respiratory tract infections	-	5	5
Vomiting	-	4	4
Stridor	2	-	2
Hoarseness	1	-	1
Cyanosis	1	-	1
Convulsion	1	-	1

Table 9: Signs

Signs	no. Of cases		
	laryngo tracheal	bronchial	Total
Decreased or absent air entry	2	33	31
Dyspnea	4	18	22
Crepitations	2	17	18
Fever	1	26	27
Rhonchi	1	14	15
Cyanosis	2	7	09
Trails signs	-	10	10
Intercoastal retractions	-	10	10
Wheeze	-	10	10
Stridor	4	02	6
Treacheal thud	1	-	1
Subcutaneous emphysema	-	-	-
Altered sensorium	1	-	1

Table 10:.Radiological Signs

Findings	no. Of cases		
	laryngo tracheal	Bronchial	Total
Emphysema	1	30	31
Pneumonitis	-	10	10
Mediastinal shift	-	10	10
Collapse	-	3	3
Bronchopneumonia	1	3	4
Radio opaque foreign body	1	1	2
Pneumo mediastinum	-	-	-
Pneumothorax	-	1	1
Bronchiectasis	-	2	2
No pathology	4	2	6

The airways can be invaded by foreign substances from the animal, vegetable, or mineral kingdoms. These foreign bodies may originate from within the body (endogenous, such as purulent material, mucous secretions, blood clots, sequestrates, or worms) or be introduced from external sources (exogenous), entering via natural passages (aspirated or swallowed objects) or through direct penetration (e.g., bullet, dart, drainage tube from the neck) (Jackson). In this study, cases of exogenously aspirated foreign bodies were analyzed.

The Data Collected in this Study will be Discussed Under Two Primary Headings:

- Foreign Bodies in the Nose.
- Foreign bodies in the laryngotracheobronchus.

In this study, 70% of children presented with foreign bodies in the nose. The majority of these children (90%) were younger than 4 years of age, with a higher incidence in males. Once children become mobile and independent, they often develop curiosity about objects, which leads them to insert items into their nasal or oral cavities. The increased incidence in males is not fully understood, but it could be attributed to their generally higher activity levels. Nasal foreign bodies are uncommon in older children. Of the cases, 86% presented with unilateral nasal obstruction, 52% with nasal discharge and 44% with epistaxis. On per-speculum examination, a foreign body was visible in 75% of cases. One notable case involved a 5-year-old mentally retarded female with maggots in both nasal cavities. In 8% of cases, the foreign body was of vegetable origin, with groundnuts accounting for 35% of cases. No complications occurred during removal, except in three instances where a groundnut was inadvertently pushed into the pharynx but was expelled spontaneously by coughing. Due to limited literature on this topic, the findings were compared to reviews by Scott Brown[8] and Rodrigues Figueiredo[9], which showed similar results, with younger children accounting for the majority of cases. The most common symptoms in their study were unilateral obstruction and nasal discharge.

Age Incidence: In this study, 70% of children were below 3 years of age, with the youngest being 8 months old and the oldest 12 years old. The mean age of presentation was 3 years. Studies by A Mahyar[10], Gulshan Hussain[11] and Arvind Sehgal[12] reported similar age distributions, with 73%, 75%, and 63% of cases, respectively, occurring in children under 3 years of age. The youngest child in Steen's study[13] was just 10 days old and had inhaled baby powder. Foreign body aspiration is most common in this age group because children are transitioning to solid foods, practicing swallowing and developing motor skills, often with less adult supervision. Additionally, children lack molar teeth, which makes chewing more difficult[14,15]. Activities such as shouting, crying and laughing while eating, as well as parental reactions like thumping or spanking, also contribute to the risk.

Sex Incidence: In this study, 70% of patients were male and 30% were female, resulting in a male-to-female ratio of nearly 2:1. Similar ratios were reported in

studies by A Mahyar[10], Boloorsaaz[16] and others. While the reason for this preponderance of male cases is unclear, it has been hypothesized that boys' more adventurous and inquisitive nature may contribute to this disparity.

Site of Foreign Body: In this study, 50% of foreign bodies were found in the right bronchus, 35% in the left bronchus and 17.5% in the laryngotracheal tree. Two foreign bodies were located in the larynx, three in the trachea and two at the carina. Both patients with foreign bodies at the carina experienced cardiac arrest and could not be revived. Postmortem examinations revealed the foreign bodies at the carina. The right bronchus is the preferred site for most bronchial foreign bodies due to its more vertical angle, greater diameter, and its position as a direct continuation of the trachea. Additionally, the greater volume of air entering the right lung during inspiration contributes to this predilection.

Symptoms and Signs: In this study, only 64% of cases had a positive history of foreign body aspiration, which is lower compared to studies by A Mahyar[10] (58%) and Kamaljeet Kaur[17] (76%). This lower incidence may be attributed to a lack of awareness and inadequate parental attention, especially in large families or rural areas. Among the patients, 38% presented within 3 days of aspiration or symptom onset. In contrast, 57% of patients with laryngotracheal foreign bodies presented within 24 hours, as symptoms in these cases tend to be more acute and severe. The most common presenting symptoms for laryngotracheal foreign bodies were cough, breathlessness and choking, while bronchial foreign bodies typically presented with cough and fever. The most frequent signs observed were decreased or absent air entry, respiratory distress, and crackles upon auscultation. Cyanosis was present in 22% of cases. Laryngeal foreign bodies were associated with dyspnoea, cyanosis and stridor, while bronchial foreign bodies often showed decreased air entry, respiratory distress, fever and crackles. Fluoroscopy was used in 15 cases, with two-thirds showing the Holzknecht-Jacobson sign as positive. Obstructive emphysema was the most common radiological finding. Additionally, two foreign bodies, a coin and a cement stone, were radio-opaque. Recent studies have demonstrated that magnetic resonance imaging (MRI), particularly T1-weighted images, can be useful in locating peanut fragments in the lower airway, as they appear as high-intensity signals surrounded by low-intensity lung tissue.

CONCLUSION

- Acute coughing, choking, breathlessness, and antibiotic-resistant respiratory infections in kids under 3 should alert for foreign body aspiration.
- Combine information from history, exams and radiology instead of relying on one.
- Nasal foreign bodies cause obstruction., laryngeal ones start acutely with no X-ray pathology., tracheobronchial may be acute/chronic.
- Fluoroscopy with expiratory X-ray is key in diagnosing aspiration.
- Fluids, corticosteroids, oxygen, antibiotics, and endoscopy improve patient condition and reduce risks.
- Rigid tube bronchoscopy under anesthesia safely removes foreign bodies.
- Prevent accidents: children shouldn't play with unsafe objects or eat nuts, and adults shouldn't hold small items in their mouths. Education, legislation and training in the Heimlich maneuver are vital. Early diagnosis and treatment can prevent damage and reduce mortality.

REFERENCES

1. Barreto R.L. and L.D. Holinger., 2005. Foreign body of airway and oesophagus Otolaryngology. In: Head and Neck surgery., In cummings C.W., (Ed.)., Mosby.,, Philadelphia.,, 0 pp: 4343-4353.
2. Bradwell R., 1633. Help for sudden accidents endangering life. London: Thomos purfoot., 113-114.
3. Biuehagen J.D., R.L. Wesenberg., J. Brooks, E.K. Cottan and F.B. Endotracheal., 1980. Difficulties in diagnosis. Clinical pediatric., 480-484.
4. Aytac *et al.,* 1977. Inhalation of foreign bodies in children Report of 500cases. J Thoracic and Cardiovascular Surgery., Vol. 145.
5. Cleveland, R.H., 1979. Symmetry of Bronchial Angles in Children. Radiology, Vol. 133 .10.1148/133.1.89.
6. Jackson C. and C.L. Jackson., 1936. Diseases of the air and Food passages of Foreign body origin Philadelphia. WB Saundus Co., Vol.
7. Chatterji, S. and P. Chatterji, 1972. The management of foreign bodies in air passages. Anaesthesia, Vol. 27 .10.1111/j.1365-2044.1972 .tb08243.x.
8. Ransome J., 2000. Foreign bodies in the nose: Scott Brown's Otolaryngology stn edition.
9. Figueiredo, R.R., A.A. Azevedo, A.O.D. Kós and S. Tomita, 2006. Nasal foreign bodies: Description of types and complications in 420 cases. Braz. J. Otorhinolaryngol., Vol. 72 .10.1016/s1808-8694 (15)30028- 8.
10. Mahyar A. and S. Tarlan., 2008. Foreign body aspiration in children. Acta Medica Iranica ., 46: 15-119.
11. Gulshan H., 2006. Foreign body in Tracheo-bronchial tree., J Ayub Med Coll Abbottabad., Vol. 18.

12. Arvind S., S. Varinder, C. Jagdish and N.N. Mathur., 2002. Foreign Body Aspiration : Indian Pediatrics. 0 39: 1006-10101.
13. Steen, K.H. and T.H. Zimmermann, 1990. Tracheobronchial aspiration of foreign bodies in children: A study of 94 cases. The Laryngoscope, Vol. 100 .10.1288/00005537-199005000-00016.
14. Bressler K.L. and C.G. Green., 1999. Foreign body aspiration. In: In: Pediatric respiratory medicine., Mosby.,, Philadelphia.,, 0 pp: 430-435.
15. Fernandez J.I., S.C. Gutierrez and M.V. Alvarej *et al.*, 2000. Foreign body aspiration in childhood-A report of 210 cases.
16. Boloorsaaz M.R., 2005. Foreign body in children airways :Tanaffos. 0 4: 49-52.
17. Heimlich H.J., 1975. A life saving maneuver to prevent food choking. Pediatrics., Vol. 398.