CHEST X-RAY FINDINGS AND TYPES OF FOREIGN BODIES IN PATIENTS PRESENTING WITH COMPLAINTS OF TRACHEOBRONCHIAL FOREIGN BODY ASPIRATION; A NINE-YEAR MULTI-CENTER PROSPECTIVE STUDY

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ABSTRACT

Objective: To analyze the x-ray findings in patients suspected of foreign body aspiration and to report different types of observed foreign bodies.

Study Design: A prospective study.

Place and Duration of Study: Combined Military Hospitals of Rawalpindi, Lahore, Malir, and Quetta following collaboration between departments of Otolaryngology, Thoracic Surgery, and Diagnostic Radiology, from Aug 2008 to May 2017.

Methodology: Patients of any age who were suspected to have foreign body aspiration into the tracheobronchial tree were consecutively included. Patients with liquid aspiration, regurgitated gastric contents' aspiration, parasite infection, or foreign body via transcutaneous penetration were excluded. All patients underwent anteroposterior and lateral imaging of the soft tissues of the neck and chest and then went through bronchoscopy under general anesthesia. Surgery was carried out if bronchoscopy was unadvisable due to the character or location of foreign body, or the patient's general condition.

Results: Out of 110 patients (mean age: 5.6 ± 6.9 years), the highest incidence (49.5%) was seen in patients ≤3 years of age (p<0.001). The male: female ratio was 2.3:1 (p<0.001). Chest x-rays showed a radiopaque foreign body as the commonest finding (28.2%). Twenty-six (23.6%) cases had a normal chest x-ray. The non-organic foreign bodies were more common than organic foreign bodies (60.9% vs 39.1%) (p=0.022). The commonest non-organic foreign body was whistle in 16 (14.5%) cases and the commonest organic foreign bodies were seeds and betel nuts found in 15 (13.6%) cases each.

Conclusion: Tracheobronchial foreign bodies had a peak incidence in children ≤3 years of age with males more affected than females. The commonest finding on chest x-ray was a radio-opaque foreign body. Non-organic foreign bodies were more frequent than organic foreign bodies and whistles made the most of recovered foreign bodies.

Keywords: Aspiration, Bronchoscopy, Chest x-ray, Foreign body.

INTRODUCTION

Foreign body (FB) aspiration into the airway is one of the commonest causes of accidents at home in children. In the United States, approximately 500-2000 deaths occur each year from FB aspiration[1]. Although FB aspiration most frequently occurs in children, it happens in adults as well. The signs and symptoms of FB aspiration vary according to age of the subject, nature of the object aspirated, location of the object, and the lapsed time since the incident[2].

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Accidental aspiration of a FB into the tracheobronchial tree in both adults and children can result in significant morbidity and mortality. A missed diagnosis can lead to lethal airway obstruction, chronic wheezing, long-drawn-out cough, and repeated pneumonia episodes. A delay in diagnosis can also result in significant airway compromise including edema, granulation tissue formation, bronchiectasis, and obstructive pneumonia[3].

Management of tracheobronchial FBs consists of clinical examination, appropriate tests to diagnose the presence of an airway FB, and quick removal of the FB from the airway. Despite

advances in the radiologic techniques, chest x-ray remains the first line radiological investigation widely available for the diagnosis of FB aspiration. In difficult cases, one may resort to other radiological investigations like computerized tomographic scan.

Food items are the most commonly aspirated FBs in various Western and Asian studies. But, at times, various bizarre non-food items including rubber balloons, plastic toys, teeth, and dental appliances have been removed from the airways[4]. The removal procedure is safe and rewarding if it is carried out with the right instruments and by the experienced physicians in specialized centers.

FBs obstructed in the airways are rarely noticed, as most of the FBs are radiolucent. These FBs produce different indirect findings, the most common being unilateral airway dilatation (emphysema) or airway collapse (atelectasis). Chest x-ray is observed normal in ~35% (range 30-40%) of the patients. The purpose of this study was to share the observed findings seen on chest x-ray during the clinical experience at multiple healthcare centers in patients suspected of FB aspiration. Report of different types of observed FBs was secondary goal of the study.

METHODOLOGY

It was a prospective study carried out in Combined Military Hospitals of Rawalpindi, Lahore, Malir, and Quetta following collaboration between departments of otolaryngology, thoracic surgery, and diagnostic radiology between August 2008 and May 2017. A sample size of 65 was calculated using World Health Organization Sample Size Calculator while keeping confidence level of 95%, anticipated population proportion of 4.4%[5], and required absolute precision of 0.05.

Patients of any age who were suspected to have FB aspiration into the tracheobronchial tree were sampled consecutively. After taking written consent from patients and/or guardians of the patients, detailed history taking and clinical examination was carried out in all cases. Patients with liquid aspiration, regurgitated gastric contents' aspiration, parasite infection, or FB via transcutaneous penetration were excluded.

All patients underwent anteroposterior and lateral imaging of the soft tissues of the neck, inspiratory and expiratory posteroanterior chest x-rays, and lateral chest x-rays using Shimadzu R-20J x-ray system (Shimadzu Corporation, Kyoto, Japan). Lateral decubitus chest x-rays were carried out in patients who are unable to cooperate with inspiratory and expiratory chest x-rays. The chest radiographs were evaluated and reported by a consultant radiologist. The findings of interest on chest x-rays were presence of a FB, lung collapse (atelectasis), hyperinflation (obstructive emphysema), nonspecific infiltration, and consolidation (pneumonia). If none of these radiological abnormalities were observed, the x-ray was reported as a normal x-ray.

All patients, after initial workup, went through bronchoscopy under general anesthesia as first-line treatment for FB aspiration. The nature and location of the FBs were recorded. If the FB was not retrieved on the first attempt, bronchoscopy with a rigid bronchoscope was repeated on the next available operation list within next three days depending upon clinical condition of the patient. Failing this, surgery was undertaken depending on patient's signs and symptoms, and suspected character and location of FB. In case, no FB was recovered, the patient was excluded from the study.

The data were recorded in predesigned proformas. The recorded parameters were age, gender, x-ray findings, and types of FBs. The Statistical Package for Social Sciences v 20.0 was used for the statistical analysis. To compare the number of patients falling in different age-groups, we divided the sample into four groups based on age i.e. age ≤3 years, age: 4-7 years, age: 8-12 years, and age: >12 years respectively. Means and standard deviations were calculated for quantitative variables and frequencies along with percentages were calculated for the qualitative variables. In order to compare the frequency of patients distributed in different age-groups

and genders, we used the chi-square goodness-of-fit test. Same test was used to compare the frequencies of organic and non-organic FBs. All tests for statistical significance had a level of significance set at ≤0.05.

RESULTS

Out of 110 patients (mean age: 5.6 ± 6.9 years, range: 1-45 years) with FB aspiration, significantly higher incidence was seen in patients ≤3 years of age accounting for 55 cases (50%) (p<0.001). Next common age-group was 4–7 years in 41 cases (37.3%). Seventy-seven (70%) patients with FB aspiration were male and 33 (30%) were female with a male: female ratio of 2.3:1 (p<0.001).

Chest x-rays showed a radiopaque FB as the commonest finding i.e. 31 cases (28.2%) (table) followed by obstructive emphysema 23 (20.9%), and atelectasis 12 (10.9%). Twenty-six (23.6%) cases had a normal chest x-ray. Non-organic FBs were more common than organic FBs (67 vs 43; 60.9% vs 39.1%) (p=0.022) (table). The commonest non-organic FB was whistle in 16 (14.5%) cases and the commonest organic FBs were seeds and betel nuts found in 15 (13.6%) cases each.

Table: Frequency and percentage of radiological findings on chest x-ray and the types of recovered foreign bodies (n=100).

Variables	n (%)	Variables	n (%)
Radiological findings		**Types of Foreign Body**	
Normal x-rays	26 (23.6)	***Non-organic foreign bodies***	67 (60.9)
Foreign Body	31 (28.2)	Whistle	16 (14.5)
Atelectasis	12 (10.9)	Bead	10 (9.1)
Nonspecific infiltration	7 (6.4)	Star (Used on clothes for decoration)	2 (1.8)
Pneumonia	11 (10)	Pieces of toy (plastic)	7 (6.4)
Obstructive Emphysema	23 (20.9)	Rubber piece	7 (6.4)
		Dental pin	1 (0.9)
		Bearing	3 (2.7)
		Needle	1 (0.9)
		Metallic toy pieces	8 (7.3)
		Screw	2 (1.8)
		Pencil cover	1 (0.9)
		Sponge piece	6 (5.4)
		Sand & cement	3 (2.7)
		Organic foreign bodies	43 (39.1)
		Peanuts	3 (2.7)
		Betel nuts	15 (13.6)
		Seeds	15 (13.6)
		Hazel nut	1 (0.9)
		Pea	5 (4.5)
		Carrot pieces	3 (2.7)
		Cabbage pieces	1 (0.9)

DISCUSSION

In the present study, maximum percentage of patients with FB aspiration was given by children ≤3 yearsof age. The higher incidence of FB aspiration in this age-group is attributed to many factors. First; the infants have an innate habit of putting new things in their mouth to get an idea of the texture and taste as the tactile sensations are maximum at the tongue. Second; children often put more food in their mouth than they can correctly chew and swallow. Third; the swallowing mechanism is not completely developed in young children and thus the ingested FBs go into the respiratory passages more often than into the esophagus. Fourth; many children talk, laugh, and run at the same time while eating[6]. Fifth; children put most objects in their mouth because they use them as counter irritants

to reduce the discomfort of teething[6]. Mallick[7], Sinha *et al*[8], Fraga *et al*[9], Sumanth *et al*[10], Jaswal *et al*[11], and Ullah *et al*[12] made similar observations with 51.8%, 62.5%, 75.4%, 45.2%, 63.4%, and 60.4% FB aspirations occurring in children less than 3 years of age. Mahafza and Khader[6], Kaddah and Ahmed[13], Naragund and colleagues[14], and Munish[2] found commonest age-group of such presentation to be ≤2 years of age.

Most of our patients with FB aspiration were male with male: female ratio of 2.3:1.Naragund and colleagues[14], Sumanth *et al*[10], Sinha *et al*[8], Mahafza and Khader[6], Fraga *et al*[9], Munish[2], Jaswal *et al*[11], Ullah *et al*[12], and Mallick[7] have also observed a male dominance with male: female ratios of 4.5:1, 2.7:1, 2.2:1, 1.5:1, 1.6:1, 1.6:1, 1.7:1, 2.4:1, and 1.6:1 respectively. The reason stated for this male predominance is more adventurous nature of males as compared to females[6].

The hallmark of an aspirated FB on chest x-ray is a lung volume that does not change during the respiratory cycle. Aspirated FBs have a predilection for the right tracheobronchial tree but both lung fields should be carefully scanned for the direct or indirect signs of FB presence. Due to the check valve mechanism, where air enters the bronchus around the FB but cannot exit, the affected lung usually appears over inflated and hyperlucent, with concomitant rib flaring and a depressed ipsilateral hemidiaphragm. The normal lung should appear smaller and denser than the affected lung. Unilateral emphysema or atelectasis is the most common finding seen on chest x-ray; only uncommonly (e.g. 4.4%)[5], a radio-opaque FB is demonstrated. However, opposite to that, the x-rays in the bulk (28.2%) of our sample showed a radiopaque FB making the diagnosis obvious on chest x-ray. The second most regular finding was obstructive emphysema seen in (20.9%) of chest x-rays. Kaddah and Ahmed[13] also found a radiopaque FB in most (78.8%) of the sampled individuals. Yetim and colleagues[15] observed radiopaque FB in the majority (59.5%) of cases followed by obstructive emphysema observed in 19% cases. Arif *et al*[16], Mallick[7], Ullah *et al*[12], and Memon *et al*[17] reported obstructive emphysema as the most common complication of FB aspiration seen on chest x-ray while Fraga *et al*[9], Sumanth *et al*[10], Jaswal *et al*[11], El dine Hamed *et al*[18] and Shah *et al*[19] found atelectasis as the most common finding in 38.8%, 34.7%, 41.65%, and 20.8% of the samples respectively.

Regarding the various types of FBs, non-organic FBs were significantly more common than organic FBs in our sample (60.9% vs 39.1%). The commonest non-organic FB was whistle in 14.5% cases. The reason for abundance of non-organic FB in our sample appears to be easy availability of cheap toys like balloons, facemasks, and whistles, plenty of which are available in the streets of all cities of Pakistan. These toys are very attractive to toddlers and many of them contain whistles. Furthermore, poor legislation on manufacturing and labeling of warning signs on these toys, makes these toys a potential hazard for choking. Kaddah and Ahmed[13], Gad and Hadidi[20], and Sehgal *et al*[4], also recovered non-organic FBs (mainly hair pins) more than organic FBs from airways of the patients in their study but the bulk of relevant medical literature[2,7-9,12,14,15-17,19,21-25] abstracts that organic FBs are more common than non-organic FBs.

The commonest organic FBs in our study were seeds and betel nuts found in 13.6% cases each. Memon *et al* and Magsi *et al*[17,21] also found betel nuts as the commonest organic FBs (63.6% and 52.5% respectively) in their studies. Munish[2], Ullah *et al*[12], Naragund and colleagues[14], Arif *et al*[16], Ahmed and Shuiabu[24], Asif *et al*[22], and Dragičević *et al*[23] observed groundnuts/peanuts as the commonest organic FBs (36.5%, 64.6%, 27.3%, 71.5%, 25.7%, 55.6%, and 37.5% respectively) in their studies. Shah *et al*[18] and Mallick[7] reported flower and fruit seeds while Fraga *et al*[9] and Oburra *et al*[25] reported beans in the majority of their patients with FB aspiration accounting for 20.8%, 55%, 21.7%, and 19.6% respectively.

Although direct or indirect signs of aspirated FB can be detected in 16% and 72% of the suspected cases, around 12% do not show any relevant trace on inspiratory and expiratory chest

x-rays. These difficult cases are usually young pediatric patients who are unable to cooperate with routine chest x-rays. Lateral decubitus chest X-ray, fluoroscopy, or both may help in diag-nosing FB aspiration in such patients[26]. As a rule, all patients with a high clinical suspicion for aspirated FB should undergo bronchoscopy for definitive diagnosis and treatment.

Most FBs are lodged in the bronchial tree, and only a small percentage (around 4%) become stuck in the larynx. Diagnosis of laryngeal FBs, especially if they are small, thin, and radiolucent, remains a challenge. Radiographs are usually normal, and typical indirect radiological signs are invariably absent. In these situations, low-dose multidetector computed tomography is used. It is a sensitive investigation that can detect radiolucent FB in the larynx as well as the tracheobronchial tree. Moreover, it can be combined with virtual bronchoscopy, a technique that has 3-dimensional surface-rendering and volume rendering possibilities, thus providing a view of the internal surface of the airways. Successful identification of laryngeal FB with low dose multidetector computed tomography and thin slice reconstruction has been reported in cases with uncertain clinical presentation and negative radiographs[25].

The patients with tracheal or laryngeal FB obstruction present with choking with or without respiratory failure. A successful treatment at the scene can be achieved through the Heimlich maneuver, back blows, and abdominal thrusts. Even in nonemergency situations, expeditious removal of tracheobronchial FB is recommended. For an ideal procedure, an experienced team including a bronchoscopist, bronchoscopy assistants, nurse, and anesthesiologist are required for successful extraction of FB. The vast majority of FBs can be extracted safely with flexible bronchoscopy and with the use of forceps and baskets. However, the use of more advanced tools often not available in the community setting and the occasional need to utilize rigid bronchoscopy suggests that FB extraction should be performed in a facility that has advanced tools and trained personnel available whenever possible.

CONCLUSION

Tracheobronchial FB aspiration had a significantly high incidence in children ≤3 years of age with significantly more males affected than females. The commonest finding on chest x-ray was a radio-opaque FB. Non-organic FBs were significantly more frequent than organic FB and whistles were the commonest recovered FBs.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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