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ARTYKUŁ ORYGINALNY / ORIGINAL ARTICLE

Factors predicting early diagnosis of pediatric laryngotracheobronchial foreign bodies

Czynniki przepowiadające wczesną diagnozę ciał obcych w krtani, tchawicy i oskrzelach u dzieci

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Article history: Received: 08.16.2015 Accepted: 22.11.2015 Published: 15.12.2015

ABSTRACT:

Objective: To study the clinical and radiological findings to make early diagnosis of foreign body (FB) aspiration in children

Methods: This prospective study was conducted on 45 children below 12 years of age with a clinical diagnosis of FB aspiration undergone rigid bronchoscopy from September 2008 to may 2010.

Results: Bronchoscopy was positive for FB in 37 children. The results of these 37 children (15 female and 22 male) were analyzed. 81% of children were in age group of 1-3 years. Penetration syndrome (sudden onset coughing, choking and gagging when the child is having something in the mouth) (89.2%) and decreased breath sounds (86.5%) were the most common clinical features. Cough, respiratory difficulty and fever were present in 83.8%, 78.4% and 27% respectively. Tachypnoea, tachycardia, chest retractions, decreased chest movements and wheeze were present in 83.3%, 83.3%, 83.3%, 51.4% and 43.2% respectively. Unilateral hyperinflation (64.9%), mediastinal shift (45.9%), and collapse (21.6%) were common radiological sign on chest radiograph and in 13.5% patients the chest X-rays were normal. Sites of FB lodgments were larynx, trachea, right main bronchus, left main bronchus and bilateral bronchi in 10.8%, 10.8%, 35.1%, 37.8 and 5.5% respectively. Food related FBs were present in 30 cases (peanut in 54.1%) and inorganic FBs were present in 7 cases. FBs were removed successfully by rigid bronchoscopy in all cases without any mortality.

Conclusions: Penetration syndrome, localized decreased breath sounds, unilateral hyperinflation and/or mediastinal shift on radiology are predictors for early diagnosis of FB aspiration.

KEYWORDS: bronchoscopy, bronchus, foreign bodies, foreign body aspiration

STRESZCZENIE:

Cel: Analiza objawów klinicznych i radiologicznych pomocnych w postawieniu wczesnej diagnozy aspiracji ciała obcego (CO) u dzieci.

Metody: Niniejsze badanie prospektywne było przeprowadzone na 45 dzieci poniżej 12 roku życia, z kliniczną diagnozą aspiracji CO, u których wykonano sztywną bronchoskopię pomiędzy wrześniem 2008 a majem 2010.

Wyniki: Wynik bronchoskopii był dodatni w kierunku aspiracji CO u 37 dzieci. Przeanalizowano wyniki badań tych 37 dzieci (15 dziewcząt i 22 chłopców); 81% dzieci należało do grupy wiekowej 1-3 lat. Do najczęstszych objawów klinicznych u tych dzieci należały: zespół penetracji (nagły atak kaszlu, krztuszenia i odruchów wymiotnych, w trakcie gdy dziecko ma coś w ustach) (89,2%) oraz ściszenie szmerów oddechowych (86.5%). Kaszel, trudności z oddychaniem oraz gorączkę stwierdzono u odpowiednio: 83,8%, 78,4% i 27% dzieci. Tachypnoe, tachykardię, zaciąganie klatki piersiowej, zmniejszoną ruchomość klatki piersiowej oraz świsty stwierdzono u odpowiednio 83,3%, 83,3%, 83,3%, 51,4% i 43,2% dzieci. W RTG klatki pier-

siowej często stwierdzano jednostronną rozedmę (64,9%), przesunięcie śródpiersia (45,9%) oraz odmę (21,6%), natomiast u 13,5% pacjentów RTG klatki piersiowej było prawidłowe. Najczęstszymi miejscami, do których aspirowane były CO, były krtań, tchawica, prawe oskrzele główne, lewe oskrzele główne, i oskrzela obustronnie z częstością aspiracji odpowiednio: 10,8%, 10,8%, 35,1%, 37,8 i 5,5% przypadków. Ciała obce będące pożywieniem stanowiły 30% przypadków (orzech ziemny w 54,1% przypadków) natomiast nieorganiczne CO znaleziono w 7 przypadkach. We wszystkich przypadkach CO zostały usunięte z sukcesem w trakcie sztywnej bronchoskopii, bez przypadków śmiertelnych.

Wnioski: Czynnikami przepowiadającymi wczesną diagnozę aspiracji CO są zespół penetracji, lokalnie ściszone szmery oddechowe, jednostronna rozedma i/lub przesunięcie śródpiersia.

SŁOWA KLUCZOWE: bronchoskopia, oskrzela, ciała obce, aspiracja ciała obcego

INTRODUCTION

"Anything that can go wrong will go wrong" says Murphy's Law and a foreign body (FB) in pediatric airway will sure go wrong if not diagnosed and removed promptly[1]. The most important aspect of diagnosis of FB aspiration is to suspect this possibility when an afebrile and playful child presents with sudden-onset airway symptoms. A mind that does not suspect FB aspiration is never going to diagnose it. Diagnosis of FB aspiration is not always a straightforward task as there are various conditions like bronchial asthma, pneumonia and upper and lower respiratory tract infection may resemble FB aspiration and vice versa[2]. A complete history, meticulous physical examination, radiology and a prompt evaluation by bronchoscopy will avoid most of morbidities and mortality associated with FB aspiration. In this descriptive study, we reiterated the above points and described the clinical, radiological and bronchoscopic findings in 37 south Indian children with FB aspiration. This article also highlights the positive predictors in history, clinical features and radiological findings that indicate the possibility of FB aspiration.

MATERIALS AND METHODS

The study was conducted among 45 children in a tertiary-care teaching hospital from September 2008 to May 2010 after obtaining clearance from the institutional ethics committee. The inclusion criteria were: children below 12 years of age who presented with a history of FB aspiration and/or suspected to have aspirated FB on the basis of clinical signs and/or radiological examination. All the children were admitted to the emergency pediatric department and were observed in the intensive care unit. Blood pressure, pulse rate, respiratory rate and temperature including SpO2 were monitored. Symptoms such as history of aspiration, cough, noisy breathing, change in voice, respiratory distress in the form of increased rate of breathing, fever, purulent expectoration, and expulsion of inhaled bits, chest pain and hemoptysis were asked for and noted. Features such as pulse rate, blood pressure, respiratory rate, stridor, inter-costals and sub-costal retraction, chest movements, bilateral air entry on auscultation were examined and noted. Appropriate resuscitative measures were undertaken whenever necessary. All children except for one underwent chest X-ray (both postero-anterior view and right and left oblique view) and X-ray of soft tissues of the neck (antero-posterior and lateral view). Those children having respiratory distress, not maintaining

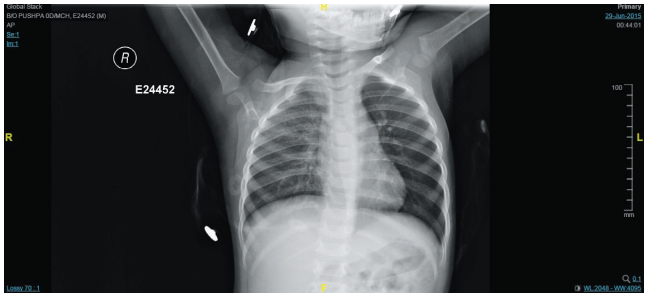

Fig. 1. Chest X-ray showing hyperinflation on the left side

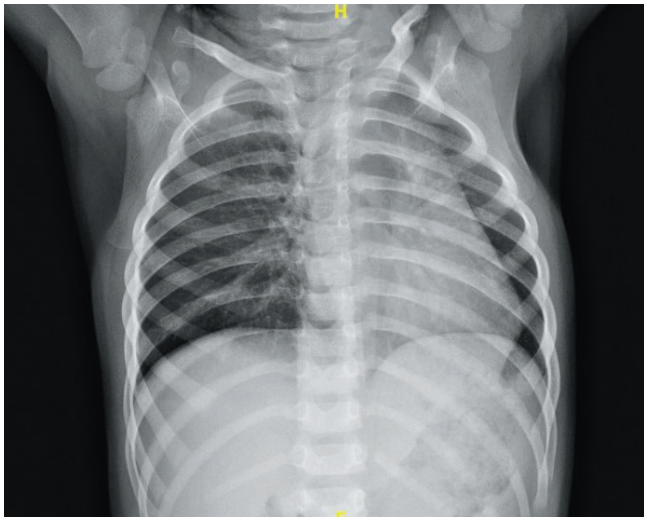

Fig. 2. Chest X-ray showing hyperinflation on the right side with shift of the mediastinum to the left side.

O2 saturation, cyanosis and suspected laryngeal or tracheal FB were taken up for emergency bronchoscopy and elective bronchoscopy was done for others at the earliest possible date. All patients received intravenous antibiotics and steroids. All bronschopies and removal of FB were performed under general anesthesia. Appropriate size of ventilatory bronchoscopes (Karl Storz rigid bronchoscopy) and forceps were used for FB removal. All patients were observed in the intensive care unit in the post-operative period. All patients showed symptomatic improvement after removal of FB. Obligatory radiological examination of the chest in the immediate post-operative period is usually not recommended and only in case of any worrying symptoms radiological examination should be done. But it is our institutional protocol to take chest X-ray after bronchoscopy even in the absence of worrying symptoms. The X-ray is taken once the child has fully recovered from the effect of anesthesia.

Nebulised bronchodilators, intravenous antibiotics and steroids were continued in the post-operative period for variable length of time depending upon the clinical and radiological recovery of the children. The patients were discharged from hospital when stable and with no signs of respiratory distress.

OBSERVATION

Forty-five children suspected to have aspirated FB underwent rigid bronchoscopy. Foreign bodies (FBs) were retrieved from the airway of thirty-seven children but in eight children no FB was found during bronchoscopy. The results of those 37 children (15 female and 22 male) with positive FB on bronchoscopy were analyzed.

AGE AND GENDER

All children were below 12 years. The mean age was 2.6 years; 32 were in age group of 1 to 3 years.

SYMPTOMS AND SIGNS

Children presented with various presenting complaints. The most common presenting complaints were history of aspiration, cough and respiratory difficulty in the form of increased rate of breathing and chest in-drawing. An important history in children with foreign body aspiration is a symptom complex including sudden-onset coughing, choking and gagging when the child is having something in the mouth (penetration syndrome). This was present in 33 children. In those without the history of penetration syndrome, FB aspiration was suspected on the basis of other symptoms, physical signs, radiological signs and flexible bronchoscopy. Two patients had hoarse cry and voice and both those patients had foreign bodies lodged in the larynx and one of those patients had stridor intermittently. Table 1 shows different symptoms of presentation in our study.

Tab. I. Symptoms of foreign body aspiration.

SYMPTOMS	NO. OF CASES	%AGE
History of aspiration (Penetration syndrome)	33	89.2
Cough	31	83.8
Respiratory difficulty	29	78.4
Fever	10	27
Change in voice	3	8.1
Noisy breathing	3	8.1
Poor feeding	1	2.7
Seizures	2	5.4
Drowsiness	1	2.7
Neck and chest swelling (surgical emphysema)	1	2.7
Asymptomatic	3	8.1
Whistling sound on breathing	1	2.7

Tab. II. Physical findings.

PHYSICAL SIGN	NO OF CASES	%AGE
Deceased breath sound	32	86.5
Tachypnoea	31	83.8
Tachycardia	31	83.8
Chest retractions	31	83.8
Decreased chest movement	19	51.4
Wheeze	16	43.2
Crepitations	5	13.5
Hoarse voice	2	5.4
Stridor	3	8.1
Subcutaneous emphysema	1	2.7

The mean duration of foreign body aspiration was 6.9 days, ranging from a few hours to 90 days.

Thirty-six out of 37 patients had at least one abnormal examination finding. A four-year-old child who had aspirated a pen cap had no findings on physical examination and his chest x-ray was normal as well. Tachycardia and tachypnoea was present in 31 patients and ten children had raised temperature at the time of admission. Blood pressure was normal for all children.

A decreased breath sound on auscultation was the most common finding being found in 32 patients (86.5%). Subcutaneous emphysema involving the anterior aspect of the chest and the neck was found in one patient who gradually subsided over 5 days post-operatively. Three patients had respiratory arrest and two of them had episodes of seizures pre-operatively. All those three patients were intubated and ventilated before being taken up for bronchoscopy. Palpatory thud was present in two cases. Physical signs elicited in our study are shown in Table 2.

RADIOLOGICAL FINDINGS

The most common radiological finding was hyperinflation and it was recorded in 24 cases. The other findings on chest radiography were mediastinal shift, collapse, consolidation, infiltrates and shifting signs (Figure-1 & 2). Radio-opaque FBs were found in 4 patients; two were metallic (screw and nail), one was chiku seed seen on anteroposterior neck radiograph and the other was brick piece. Five patients had normal chest radiography findings. Various radiological changes in our study are shown in Table 3.

BRONCHOSCOPIC FINDINGS

FBs removed during rigid bronchoscopy included both vegetable and non-vegetable materials. The most common foreign body was peanut being present in 20 patients (54.1%) (Figure-3). The other FBs included betel nut, orange seed, rice grain, chiku seed, tamarind seed, bengal gram, coconut piece, part of a tuber in one case each and unknown organic substance in two cases. Non-food-related FBs like whistle, ear ring, brick piece, screw, nail, plastic piece, stone and pen cap were present in one case each (Figure4 & 5). FBs were removed from the larynx, trachea, right main bronchus, left main bronchus and bilateral bronchi in 4 (10.8%), 4 (10.8%), 13 (35.1%), 14 (37.8) and 2 (5.5%), respectively (Figure-6). In two patients multiple fragments of a peanut were found in bilateral main bronchi and except for these cases all other foreign bodies were single. During rigid bronchoscopy the surrounding mucosal changes varied from no mucosal changes to florid granulations which were present in 3 cases.

POSTOPERATIVE COMPLICATIONS

No serious complications or death were reported in our study. Persistent cough was found in 14 patients (37.8%) and subsided in all cases with intravenous antibiotics and bronchodilators by the second post-operative day. Hoarseness was found in one patient who had a peanut in the left main bronchus. This particular patient had florid granulation surrounding the FB and had a prolonged bronchoscopy time.

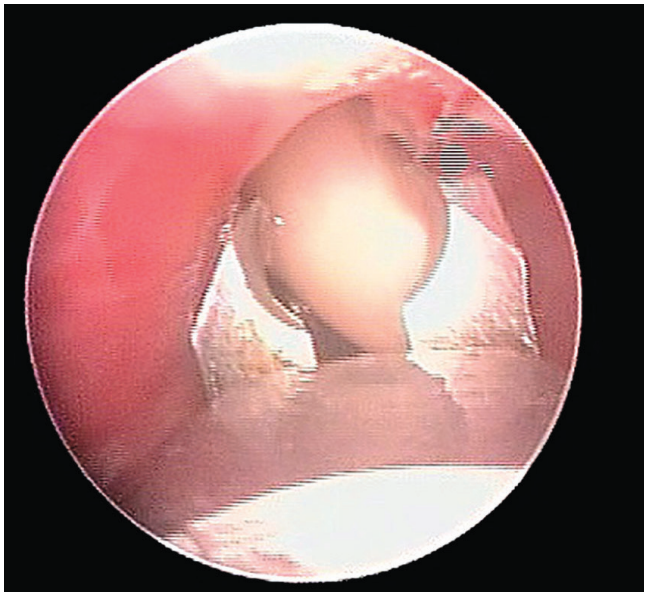

Fig. 3. Video-bronchoscopic picture showing removal of a foreign body (peanut) from the left main bronchus using optical forceps.

One patient had consolidation of the right upper lobe which resolved with antibiotics by 2 weeks. The other patient had persistent collapse of the left upper lung which recovered by the 5th post-operative period with conservative management. These two patients had a long-standing FB and granulations were present surrounding the FB.

DISCUSSION

Children in the age of 1-3 are most susceptible to FB aspiration [10, 13]. In our study 86.5% of children were in the age group of 1-3 years. Mouthing behavior in infants and young children, absence of molar teeth, incoordination of the swallowing reflex and talking while something in mouth can explain this age predominance. Children with FB aspiration present with a number of symptoms from a definite history of aspiration followed by respiratory distress to totally non-specific symptoms without any choking episodes.

A witnessed episode of choking is an important piece of evidence in history in the diagnosis of FB aspiration. Eliciting this history is vital to diagnosis of foreign body aspiration and to prevent any delay in diagnosis. This history was present in

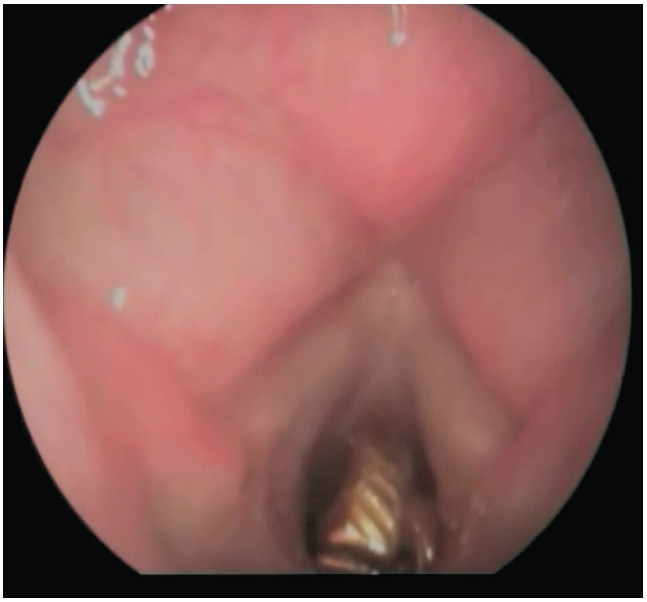

Fig. 4. Video-laryngoscopic picture showing an ear ring in the subglottis

Fig. 5. Video-bronchoscopic picture showing a foreign body whistle in the left main bronchus.

56% to 87% of cases in various reported series[7, 8, 10]. In our study this episode of choking suggestive of aspiration was present in 33 patients (89%). All children presenting with sudden-onset respiratory symptoms should be asked for a history suggestive of aspiration. However, a positive history of choking may be misleading in some cases of respiratory illness which are not due to foreign body aspiration. An unnoticed FB aspiration and initial non-specific symptoms may contribute to a late diagnosis [14]. Apart from a positive history of aspiration, the next most common symptom in our study is cough (83.8%) followed by respiratory distress (78.4%). In other studies cough was reported in a varying proportion of patients (77% [7], 82.5% [8], 30.5% [10], 100%[13]). Respiratory distress was present in 25%[7] and 49.4%[8] in other studies. Severe respiratory obstruction can lead to hypoxia and seizures, present in two of our patients. History of voice change is highly suggestive of laryngeal foreign body. Children can present with no respiratory symptoms and only history of a choking episode. Diagnosis in these children depends on physical findings and radiological changes. Hemoptysis (0.9%)[8] , expulsion of inhaled bits of a foreign body (1.8%)[8], postural dyspnoea (4.9%)[8], halitosis (1.4%)[15], vomiting (10%)[15] and purulent expectoration (4.7%)[8] have been described as symptoms of FB aspiration [8,10,15]. We did not encounter any patient with these symptoms in our study. In our study the most common physical finding was ipsilateral decreased breath sounds on examination, found in 86.5% of patients. That was followed by tachypnoea (83.8%) and chest retractions (83.8%).

Stridor was present in three of our patients (8.1%). Fever was documented in 10 of our patients (27%). Varied incidence of decreased air entry (50% [9], 66.7% [13], 39.1% [15]), tachypnoea (67% [8], 40.1%[13]), stridor (50%[9], 22.2%[13]), decreased chest movements (33.3% [9]), and crepitations (10%[9], 14.8% [13]) has been reported in cases of FB aspiration. Progressive subcutaneous emphysema is an unusual clinical feature in FB aspiration [17, 19]. The causes of pneumo-mediastinum with or without subcutaneous emphysema over the neck and chest include asthma, respiratory infection, pharyngeal or esophageal injury, cystic fibrosis, trauma, diabetes and leukemia [17]. While asthma and respiratory infection are the most common non-traumatic causes, FB aspiration which can resemble these two conditions can also present with subcutaneous emphysema [17]. Subcutaneous emphysema and pneumo-mediastinum occur due to any condition that creates a gradient between intra-alveolar and perivascular interstitial pressures. A continuum of fascial planes connects cervical soft tissues with the mediastinum and retro-peritoneum, permitting aberrant air arising in any one of these areas to spread elsewhere [18].

The spectrum of findings in a chest radiograph includes normal X-ray, typical of FB aspiration and uncharacteristic findings [5]. Presence of a normal radiograph depends on the type, site of foreign body lodgment and time of diagnosis. Normal radiographs are more common in non-vegetable FBs, in tracheal FBs and FBs diagnosed early [5]. In our study, normal chest x-ray was found in 5 patients (13.5%).

Zerella et al[5] reported normal chest x-rays in 42% of bronchial FBs and 81% of tracheal FBs. The rates of normal chest radiographs in various studies are 6.1% [8], 50% [9], 22.2%[13] and 22%[14]. Unilateral air trapping (hyperinflation), atelectasis or infiltrates are said to be characteristic of FB aspiration apart from finding a radio-opaque FB [5,20]. Findings such as bilateral pneumonia, bilateral emphysema, upper lobe atelectasis and pneumonia are uncharacteristic of FB aspiration [5]. The most common radiological sign associated with FB aspiration differs among the various studies. *Sinha et al*[9] reported mediastinal shift (33%) as the most common radiological sign followed by atelectasis (17%) in a study of 30 cases. Obstructive emphysema was found to be the most common radiological sign by *Banerjee et al*[8] (41.2%), *Roda et al*[14] (42%), *Chik et al*[13] (51.9%) and *Narasimhan et al*[10] (69.3%). Unilateral atelectasis was found to be the most common sign being present in 38.8% in a Brazilian study of 69 patients [15]. Shifting radiological finding was found in 4 of our patients (10.8%) and 3 patients had bilateral hyperinflation (8.1%). Shifting foreign bodies cause changes in the patterns of obstruction and the interplay between this and underlying inflammatory response leads to changing radiological signs.

Rigid bronchoscopy is the gold standard in the diagnosis and treatment of FB aspiration. "Do not fail to search for a FB endoscopically in all cases of doubt" said Chevalier Jackson and through a meticulous analysis of mechanical problems related to FBs in the air and food passages and their solution, created a science of rehearsed and tested instrumental techniques for their extraction. He developed instruments to achieve remarkable results with an almost unbelievably low morbidity and mortality [1]. ***Mantor et al***[4] proposed that some negative bronchoscopies are necessary in order to prevent the morbidity that occurs from a missed FB aspiration[4]. Until x-ray examination, physical examination, indirect examination and endoscopy have all proven negative, the patient should not be informed that there is no FB in the airway.

Tab. III. Chest radiographs findings.

RADIOLOGICAL FINDINGS	NO OF CASES	%AGE
Hyperinflation	24	64.9
Mediastinal shift	17	45.9
Collapse	8	21.6
Normal x-ray	5	13.5
Consolidation	4	10.8
Radio-opaque foreign bodies	4	10.8
Infiltration	4	10.8
Shifting sign	4	10.8
Not taken	1	2.7

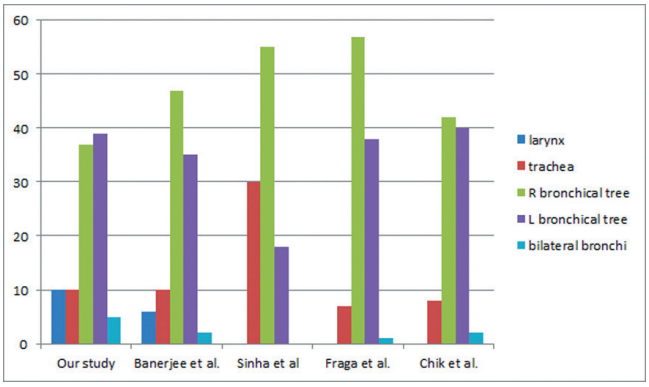

Fig. 6. Shows the comparison between our study and other studies regarding the site of FBs in the airway.

Subglottic, carinal and bilateral FBs were associated with difficult removal during rigid bronchoscopy [10]. In small infants the lumen of 2.5 mm of a bronchoscope may not provide adequate vision for the FB to be removed without causing injury to the bronchus [8]. A large vegetable FB (tamarind seed) may swell and pose difficulty during removal and warrant a tracheostomy [10]. A similar case of tamarind seed in the left main bronchus was successfully removed by rigid bronchoscopy in our study. The most common site of FB in the airway is left side of the bronchial tree in our study (37.8%) whereas in other studies it is reported to be the right side of the bronchial tree. On the basis of tracheobronchial anatomy, an inhaled FB is more likely to enter the right bronchial tree than the left at all ages. However, the variability in the position of the carina with respect to the mid-trachea may explain why this right-sided preference is less marked in children compared to adults [11]. Figure 1 shows the comparison between our study and some other studies regarding the site of FBs in the airway.

Complications following FB aspiration and bronchoscopy include pneumonia,

atelectasis, tracheal laceration, vocal cord injury, pneumothorax, tracheitis, bronchitis, cardiorespiratory arrest and death [3,10]. The rate of complications due to rigid bronchoscopy removal of airway FBs has been reported as 5% [6], 29% [13], and 33.3% [3]. *Zerella et al*[5] reported three patients with serious complications due to FB aspiration and bronchoscopy in a study involving 293 children. Those were vocal cord injury, tracheal laceration and severe subglottic edema [5]. Repeat bronchoscopy rate in various studies was 0.03% [10] and 0.02% [3]. Chik et al [13] reported repeat bronchoscopy rate of 14% in a study involving 27 cases. None of the patients in our study required repeat bronchoscopy. In a study of 69 Brazilian children, 29% presented complications

(most commonly pneumonia), which were found to be associated with longer aspiration time. Mechanical ventilation was required in 7 children (10.1%), and multiple bronchoscopies were performed in 5 (7.2%). The other complications that were described in this study include atelectasis, barotraumas, tracheal laceration and granulomatous stenosis [15]. Mortality due to FB aspiration and its treatment is 0.04%[10], 0.01%[3] and 0.9% [8].

Chung et al [21] reported the factors affecting post-operative pulmonary recovery in pediatric patients undergoing bronchoscopic removal of FBs. More than 1 week for the complete pulmonary recovery was required in 25 (25.5%) cases, whereas 74.5% of subjects fully recovered within 1 week after the removal of a foreign body. The recovery time of more than 1 week after rigid bronchoscopic retrieval of airway foreign body was associated with pre-operative inflammatory findings by radiological study, a prolonged procedure, i.e. over 50 minutes long, and aggravation of the immediate post-operative radiological findings. Therefore, long-term pulmonary care is required for this group of patients [21]. According to *Roh et* ***al*** [12] delayed lung recovery after rigid bronchoscopic removal of tracheobronchial FBs can be predicted by FB-induced inflammatory chest radiological findings and the unsuccessful or complicated removal of FBs.

CONCLUSION

FB aspiration is an important cause of acute respiratory morbidity in children. Children most commonly aspirate common food stuff. A history of a symptom complex of "penetration syndrome" or sudden onset of paroxysmal cough is a definite pointer towards diagnosis. The clinical findings in FB aspiration may be variable and mostly include decreased breath sounds, tachypnoea, and chest retraction and decreased chest movements. Radiological evaluation is useful with changes such as hyperinflation, mediastinal shift and collapse. Rigid bronchoscopy is safe and effective in the removal of airway foreign bodies in children.

ACKNOELEDGMENTS:

We thank Dr. Mahalakshi Sivaraman MD, for her valuable help with the statistical analysis.

REFERENCES

1. Jackson C. Diseases of the air and food passages of foreign body origin. Philadelphia: W B Saunders, 1936.
2. Svedstrom E, Puhakka H, Kero P. How accurate is chest radiography in the diagnosis of tracheobronchial foreign bodies in children? Pediatr Radiol 1989:19:520–522.
3. Steen KH, Zimmermann T. Tracheobronchial aspiration of foreign bodies in children: a study of 94 cases. Laryngoscope 1990; 100:525–30.
4. Mantor PC, Tuggle DW, Tunell WP. An appropriate negative bronchoscopy rate in suspected foreign body aspiration. Am J Surg. 1989; 158(6):622-4.
5. Zerella JT, Dimler M, McGill LC, Pippus KJ. Foreign body aspiration in children: value of radiography and complications of bronchoscopy. J Pediatr Surg 1998; 33:1651-4.
6. Black RE, Johnson DG, Matlak ME. Bronchoscopic removal of aspirated foreign bodies in children. J Pediatr Surg. 1994 May; 29(5):682-4.
7. Wiseman NE. The diagnosis of foreign body aspiration in childhood. J Pediatr Surg. 1984; 19(5):531-5.
8. Banerjee A, Subba Rao KSVK, Khanna SK et al. Laryngotracheal foreign bodies in children. J Laryngol Otol 1988; 102:1029-32.
9. Sinha V, Memon R, Gupta D, Prajapati B, Bhat V, More Y. foreign body in tracheobronchial tree.Indian J. Otolaryngol. Head Neck Surg.2007; 59;211-214.
10. Narasimhan KL, Chowdhary SK, Suri S, Mahajan JK, Samujh R, Rao KLN. Foreign body airway obstructions in children- lessons learnt from a prospective audit. J Indian Assoc Pediatr Surg 2002; 7: 184-9.
11. Tahir N, Ramsden WH, Stringer MD. Tracheobronchial anatomy and the distribution of inhaled foreign bodies in children. Eur J Pediatr. 2009;168(3):289-95.
12. Roh JL, Hong SJ. Lung recovery after rigid bronchoscopic removal of tracheobronchial foreign bodies in children. Int J Pediatr Otorhinolaryngol. 2008; 72(5):635-41.
13. Chik KK, Miu TY, Chan CW. Foreign body aspiration in Hong Kong Chinese children. Hong Kong Med J. 2009; 15(1):6-11.
14. Roda J, Nobre S, Pires J, Estêvão MH, Félix M. Foreign bodies in the airway: a quarter of a century's experience. Rev Port Pneumol. 2008; 14(6):787-802.
15. Fraga Ade M, Reis MC, Zambon MP, Toro IC, Ribeiro JD, Baracat EC. Foreign body aspiration in children: clinical aspects, radiological aspects and bronchoscopic treatment. J Bras Pneumol. 2008; 34(2):74-82.
16. Saki N, Nikakhlagh S, Rahim F, Abshirini H. Foreign body aspirations in infancy: a 20-year experience. Int J Med Sci. 2009: 14; 6(6):322-8.
17. Findlay CA, Morrissey S, Paton JY. Subcutaneous emphysema secondary to foreign-body aspiration. Pediatr Pulmonol. 2003; 36(1):81-2.
18. Maunder RJ, Pierson DJ, Hudson LD. Subcutaneous and mediastinal emphysema. Pathophysiology, diagnosis, and management. Arch Intern Med. 1984; 144(7):1447-53.
19. Saoji R, Ramchandra C, D'Cruz AJ. Subcutaneous emphysema: an unusual presentation of foreign body in the airway J Pediatr Surg. 1995; 30(6):860-2.

20. Paşaoğlu I, Doğan R, Demircin M, Hatipoğlu A, Bozer AY. Bronchoscopic removal of foreign bodies in children: retrospective analysis of 822 cases. Thorac Cardiovasc Surg. 1991; 39(2):95-8.

21. Chung MK, Jeong HS, Ahn KM, et al. Pulmonary recovery after rigid bronchoscopic retrieval of airway foreign body. Laryngoscope 2007; 117:303-7.

Word count: 3400 Tables: 3 Figures: 6 References: 21

Access the article online: DOI: 10.5604/00306657.1184544 Full-text PDF: www.otolaryngologypl.com/fulltxt.php?ICID=1184544

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Competing interests: The authors declare that they have no competing interests.

Cite this article as: Parida P., Shanmugasundaram N., Gopalakrishnan S., Saxena S. : Factors predicting early diagnosis of pediatric laryngotracheobronchial foreign bodies. Otolaryngol Pol 2015; 69 (6): 45-52