25-Year Review of the Abundance and Diversity of Radiopaque Airway Foreign Bodies in Children

Nader Saki · Soheila Nikakhlagh · Seyed Mohammad Heshmati

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Abstract This study was conducted to review the abundance and diversity of radiopaque foreign bodies over a 25-year period. Overall records of 1,114 patients who underwent rigid bronchoscopy due to foreign body aspiration in the tertiary centres, Imam Khomeini and Apadana; over a 25-year period (1989–2014) were reviewed. History, clinical findings, plain radiography and bronchoscopic findings, foreign body (FB) aspiration (whether radiolucent or radiopaque), time from onset of symptoms until hospitalization, and delay time were all considered. The male/female ratio was 1.53. Most patients were aged 1–3 years (53.94 %). The most common location of foreign bodies was the right main bronchus (54.57 %). The most common type of radiopaque foreign body was meat, chicken and big fish bones (4.84 %) followed by metal objects (4.39 %). Coughing (70.82 %) and cyanosis (22.80 %) were the most common symptoms. The most common radiological findings were emphysema (32.31 %). Given that the radiological findings are highly specific as regards the detection of radiopaque FB, radiographic examination prior to

bronchoscopy for FB localization and shortening the time of bronchoscopy in patients with a history of radiopaque FB aspiration can be helpful. Due to the high morbidity and mortality caused by prolong and repeated bronchoscopy, the use of newer techniques and equipment in shortening extraction time of the foreign bodies should be considered in future researches.

Keywords Foreign body aspiration · Radiopaque · Children · Bronchoscopy · Imaging

Introduction

Foreign body (FB) aspiration is a major health problem that often affects children, and a significant proportion of FB aspiration objects are Radiopaque [1, 2]. FB aspiration accounts for 7 % of all sudden deaths in children less than 4 years old in the United States of America [3, 4]. Coughing, choking, acute respiratory distress and acute onset of wheezing are the most common symptoms of FB aspiration, though these symptoms can be quickly relieved even while the FB remains [2]. The most common form of aspirated material is food [5–9]. Rigid bronchoscopy is recommended for children with FB aspiration impression [10, 11]. Radiopaque FB aspiration, with a prevalence of 7–27 % of FB aspiration, can leave a variety of complications if not diagnosed and treated properly.

FB aspiration has been reported, but its frequency varies widely, depending upon local conditions, different foods and the individual's health. In previous studies carried out regarding the evaluation of FB aspiration, radiolucent FBs were more often considered in relation to radiopaque FBs, while radiopaque objects are important because were detected more quickly and easily with available equipment,

N. Saki · S. Nikakhlagh · S. M. Heshmati
Department of ENT, Hearing and Speech Research Centre,
Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
e-mail: ahvaz.ent@gmail.com

S. Nikakhlagh
e-mail: nikakhlagh.s@gmail.com

S. M. Heshmati
Student Research Committee, Ahvaz Jundishapur University of
Medical Sciences, Ahvaz, Iran

S. M. Heshmati (✉)
Unit 34, No 19, Paniz bldg, Parzin Baghdadi St, Zaferaniye,
19879-13776 Tehran, Iran
e-mail: mooe_360@yahoo.com

such as plain radiography. Accordingly, we examine patients with radiopaque FB aspiration as a step towards improving the process of the diagnosis and treatment of these patients.

Materials and Methods

In this retrospective study all children under 14 years with FB aspiration complaints referred from clinics to general hospitals and finally referred to our subspecialty hospitals; Imam Khomeini and Apadana, Ahvaz, Iran—as tertiary centres which are the only centres for bronchoscopy in the state Khuzestan—and rigid Bronchoscopy was performed to, under general anesthesia, with different sizes depending on patients age, then foreign bodies were extracted with appropriate forceps.

This process was reviewed over a 25 year period (January 1989–January 2014) and collected data was classified based on the history, physical examination type of the FB (radiopaque or radiolucent), signs and neck, lung and abdomen plain radiography. Admission times (length of time between the beginning of symptoms and the performance of bronchoscopy) and delay times and impressions were considered. According to the elapsed time from the start of symptoms to their referral, they were classified into two groups: those who were admitted within 24 h were called ‘early’, and those were diagnosed after 24 h or else who else were admitted afterwards was called ‘late’. Data were presented using descriptive statistics and included frequency, percentage and mean $\pm$ SD criteria. The information was then analysed by SPSS 22.0.

Results

Overall, 1,114 patients with FB aspiration were admitted to the Imam Khomeini and Apadana hospitals, Ahvaz, from 1989 to 2014. The ratio of male-to-female was 1.53:1. Most of the accidents occurred at age 1–3 years, totalling 601 (53.94 %) cases (Table 1). The average age was 2.4 years (range 2 months–10 years). The youngest patient was 3 months old, who had aspirated almond.

Represented by 712 patients (63.91 %), seeds made up the highest proportion (Table 2). Obstructive emphysema, in 360 patients (32.31 %), was the most common radiological finding (Table 3). CT scan was used to identify long-term pulmonary complications. The most frequent symptom was coughing, in 789 (70.82 %) patients. Most of the patients (466) were referred back in 1–7 days.

Seeds were the most frequent organic objects. Among mineral materials, metal objects were the most common 49 (4.39 %). Meat, chicken and big fish Bones objects were

Table 1 Demographic data of patients

Variable	N	Percentage
Age (years)		
<1	238	21.36
1–3	601	53.94
4–6	175	15.70
>6	100	8.97
Gender		
Male	675	60.59
Female	439	39.40
Foreign body location		
Right main bronchus	608	54.57
Left main bronchus	213	19.12
Trachea	173	15.52
Vocal cord	97	8.70
Both bronchus	23	2.06
Radiopaque FBs type		
Meat, chicken and big fish bones	54	47.78
Metallic objects	49	43.36
Bullet	5	4.42
Coil	5	4.42
Total	113	100

Table 2 Variation of foreign bodies in the respiratory tract

Foreign body	No. of patients	Percentage
Seed	712	63.91
Food material	132	11.84
Peanut	99	8.88
Meat, chicken and big fish bones	54	4.84
Metallic object	49	4.39
Plastic object	27	2.42
Paper	19	1.70
Stone	12	1.07
Bullet	5	0.44
Coil	5	0.44
Total	1,114	100

Table 3 Imaging findings in patients with foreign bodies

Dominant radiographic changes	Number	Percentage
Emphysema	360	32.31
Radiopaque foreign body	128	11.49
Bronchiectasis/bronchitis	140	12.56
Atelectasis	100	8.97
Pneumonia	29	2.60
Normal CXR	357	32.04
Total	1,114	100

Fig. 1 The variety of foreign bodies. **a** Whistle; **b** Scarf pin; **c** Pin in lateral view; **d** Pin in PA view

the most common radiopaque FBs, at 54 found (47.78 %), followed by metal objects in 49 cases (43.36 %) (Fig. 1; Tables 2, 4).

Discussion

FB aspiration is a frequently discussed issue in paediatrics; however, the disease is often not diagnosed because there are no distinctive clinical manifestations. In Gursu et al.'s study regarding sensitivity and specificity of clinical history, symptoms, physical examination findings and radiological findings noted respectively, 90.5, 24.1, 97.8, 7.4 and 96.4, 46.3, 71.7, 74.1 %. Symptoms, physical examination and patient history are highly sensitive and radiological findings have maximum specificity [10]. Previous reports suggest that children in the first and second years of life are mainly exposed to FBs (63.5 %) [2, 12, 13]. Delayed diagnosis causes various complications, depending upon the location of the FB [14]. Following diagnosis, immediate bronchoscopy is necessary because it reduces the risk of complications. In a study by Karen in 2013 of 17,537 children, 160 deaths were caused by airway obstruction due to delays in performing bronchoscopy [15]. In our study, bronchoscopy was repeated twice in 11 cases (0.97 %), and in Tang's study [16] in China this was 4.4 %. In Bittencourt's study [17], thoracotomy was necessary in 2.1 % (3 of 140) and 1.6 % (102 of 6,393) of cases and lung resection was performed in 0.9 % of cases. With FB

aspiration, bronchiectasis and lung damage can occur as a late complication [18]. In Guidi's study [19], the proportion of males to females was (1.8:1). The most common type of FB aspiration varies from region to region. The most common type of mineral bodies in children are beads, coins, pins, small parts, small toys and stationary applications, such as pen caps. In a study of Orji and Akpehin, Nigeria 27 % of the FBs were radiopaque [3]. Sersar et al., in Egypt in a study on 3,300 patients, found that 23 % were radiopaque [2]. In a 15-year study by Chung-Hua, in China, chicken bones (12 cases) and fish bones (9 cases) (21 cases overall, 48.8 %) were the most common radiopaque FBs [20], which is consistent with our study. In a study by Nikakhlagh et al., the most common radiopaque objects were either meat and chicken bones (54 cases, 5.3 %) or metal (44 cases, 4.4 %) [12], while in Boufersaoui's 2013 study of 2,624 patients in Algeria, metal objects (272 cases, 10.36 %) (Hairpins alone counted for 169 cases, along with nails, screws, etc.) were most common [21]. In a study by Joseph et al. in Arizona, United States, nails and screws (6.41 %) were the most common radiopaque FBs [22], while Lan-Fang et al. in a 2009 study [23] of 1,027 children in Hangzhou, China, report 6.62 % radiopaque objects, comprising Fish bones in 27 cases (2.6 %) and pig bones in 22 cases (2.1 %). In Wojciech et al.'s study in 2011 in Poland, radiopaque bodies constituted 7.14 %, all of which were made of metal [24]. 4.34 % of total FBs aspirated in a 2012 study by Budensab noted a majority of coins among radiopaque objects [25].

Table 4 Comparative studies in the world of radiopaque foreign bodies

No. of patients	Study duration (years)	Commonest radiopaque FB	Commonest FB	Most common clinical symptoms (% Frequency)	Most common age (% Frequency)	M:F	Reference—country
2,624	24 years (1989–2012)	Scarf pins	Peanuts	Cough (70 %)	1–3 years (66 %)	1,635:989	Boufersaoui et al.—Algeria [21]
293	10 years (1988–1997)	Pins	Nuts	Choking (77 %)	1–3 years (64 %)	–	Joseph et al. 1998—USA [22]
87	8 years (1990–1998)	Metals	Nuts	Choking (81 %)	<3 years (79 %)	57:30	Metrangolo et al. 1999—Italy [31]
263	15 years (1990–2005)	Needle	Sunflower seed	Cough (87 %)	<3 years (56 %)	176:87	Sirmali et al. 2005—Turkey [32]
43	15 years (1980–1995)	Chicken bone	Bone	Cough (67 %)	–	35:8	Chen et al.—China [20]
1,027	8 years (2000–2008)	Fish bone	Peanuts	Cough (84 %)	<3 years (72 %)	626:401	Tang et al.—China [23]
45	10 years (2000–2010)	Metals	Nuts	–	1–3 years	27:18	Korlacki et al.—Poland [24]
72	10 years (1995–2005)	Fish bone	Seeds	Dyspnea (77 %)	<3 years (81 %)	46:26	Sílvia Teresa et al. 2009—Brazil [33]
115	4 years (2009–2012)	Metals	Peanuts	Cough (53 %)	1–3 years (74 %)	75:40	Budensab et al.—India [25]
120	7 years (1997–2003)	Needles	Ground nuts	Cough (70 %)	1–3 years (55 %)	93:27	Gandhi et al. 2007—India [46]
548	10 years (1987–1997)	Metals	Dried nuts	Cough (83 %)	2–4 years (23 %)	305:243	Oguzkya et al. 1998—Turkey [47]
44	5 years (2001–2006)	–	–	Cough (82 %)	<3 years (77 %)	–	Rahbarimanesht et al. 2008—Iran [34]
1015	20 years (1998–2008)	Meat and chicken bones	Seeds	Cough (73 %)	1–3 years (54 %)	644:371	Nikakhlagh et al. 2009—Iran [12]
316	10 years (1995–2005)	Coins	Ground nuts	Breathlessness (93 %)	1–3 years (69 %)	139:67	Kalyanappagol et al. 2007—India [35]
40	4 years (1996–2000)	–	Whistle	Cough (75 %)	5–16 (60 %)	28:12	Rehman et al. 2000—Pakistan [36]
189	4 years (1997–2001)	–	Pip	Choking (43 %)	1–3 years (72 %)	105:84	Erikoj et al. 2003—Turkey [37]
357	10 years (1990–2000)	Needle	Needle	Cough (78 %)	10–25 years (43 %)	151:206	Eroglu et al. 2003—Turkey [38]
78	5 years (1997–2002)	–	Seeds	–	<3 years (89 %)	45:33	Göktas et al. 2009—Germany [39]
96	12 years (1995–2007)	–	Peanuts	Cough (82 %)	1–3 years (32 %)	62:34	Cobanoğlu et al. 2009—Turkey [40]
27	13 years (1993–2006)	Tooth	Peanuts and watermelon seeds	Cough (100 %) and history of choking (78 %)	–	–	Chik et al. 2009—Hong kong [41]
32	14 years (1987–2008)	Pins	Inorganic objects	Acute infection (25 %)	–	21:11	Blanco et al. 2009—Spain [42]
210	8 years (1991–1999)	–	Nuts	Suffocation history (91.5 %)	1–2 years (53 %)	134:76	Skoulakis et al. 2000—Greece [43]
132	20 years (1997–2007)	–	Peanuts	Wheeze and cough (53 %)	1–3 years (41 %)	80:52	Yadav et al. 2007—Singapore [44]
244	10 years (1994–2003)	Chicken bone	Peanuts	–	<3 years (68 %)	107:75	Latifi et al. 2006—Kosovo [45]
1,114	25 years (1989–2014)	Meat, chicken and big fish bones	Seeds	Cough (70.82 %)	1–3 years (53.94 %)	675:439	Saki et al. 2014—Iran (Current Research)

In our study, the most common FBs were beans. Gang, in his 2012 research, reported peanuts as the most common FBs to be aspirated [26]. The most common FBs in East Asian countries, such as China, were organic objects, such as nuts (fresh and dried) and peanuts, while in European countries, such as Italy and Kosovo, organic materials including dried nuts were the most common. Mineral objects were most common in some countries, such as Spain [21]. Recently putting the scarf pin on the mouth while wearing the headscarf mentioned as a risk factor for FB aspiration, especially in Muslim countries, such as Turkey, Egypt, Kuwait, Jordan and Morocco [27–29]. A study was performed of 2,624 Algerian children in 2013, and the most common FBs were found to be peanuts, peas and sunflower seeds, the latter of which were the most dangerous [21]. A possible reason behind delays in recognition is that parents can be unaware of the importance of symptoms such as coughing and choking. Because the symptoms exhibited by children following choking are usually not severe, parents do not take speedy action unless the coughing or fever continues. In most cases, FB aspiration has occurred while the parents are there, and so public education is useful in reducing the phenomenon [30].

Conclusions

The diagnosis of FB aspiration in children is difficult because their symptoms can be confused with asthma or respiratory infection, which can result in delays in diagnosis and treatment. Although the mortality rate due to FB aspiration is low, cooperation between the otolaryngologists, paediatrics and radiologists for rapid diagnosis and appropriate treatment is essential. Given that the radiological findings are highly specific as regards the detection of radiopaque FB, radiographic examination prior to bronchoscopy for FB localization and shortening the time of bronchoscopy in patients with a history of radiopaque FB aspiration can be helpful.

Due to the high morbidity and mortality caused by prolonged and repeated bronchoscopy, the use of newer techniques and equipment in shortening extraction time of the foreign bodies should be considered in future researches.

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