



Contents lists available at SciVerse ScienceDirect

## International Journal of Pediatric Otorhinolaryngology

journal homepage: [www.elsevier.com/locate/ijporl](http://www.elsevier.com/locate/ijporl)

## Foreign bodies in the airways: A meta-analysis of published papers

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## ARTICLE INFO

## Article history:

Available online 12 February 2012

## Keywords:

Airways

Foreign body

Meta-analysis

## ABSTRACT

**Background:** Very recently, some attempts have been made to start a systematic collection of foreign bodies (FB) in view of using them to characterize the risk of choking in terms of size, shape and consistency of the FB. However, most of the epidemiologic evidence on foreign bodies in children comes from single-center retrospective studies, without any systematic geographical and temporal coverage. This paper is aimed at providing an estimate of the distribution of foreign body's injuries in children according to gender, age, type of FB, site of obstruction, clinical presentation, diagnostic/therapeutic procedures, complications, as emerging from a meta-analytic review of published papers.

**Methods:** A free text search on PubMed database ((foreign bodies) OR (foreign body)) AND ((aspiration) OR (airways) OR (tracheobronchial) OR (nasal) OR (inhalation) OR (obstruction) OR (choking) OR (inhaled) OR (aspirations) OR (nose) OR (throat) OR (asphyxiation)) AND ((children) OR (child)) finalized to identify all English written articles referring to foreign body inhalation over a 30 years period (1978–2008) was performed. The target of the analysis has been defined as the proportion of injuries as reported in the studies, stratified according to children demographic characteristics, type of FB, site of obstruction. The pooled proportions of FB were calculated using the DerSimonian and Laird approach.

**Results:** 1699 papers were retrieved and 1063 were judged pertinent; 214 English written case series were identified, among them 174 articles were available and have been included in the analysis. Airway foreign body most commonly occurs in young children, almost 20% of children who have inhaled foreign bodies being between 0 and 3 years of age. Organic FB, particularly nuts, are the most documented objects while, among inorganic FBs, the greatest pooled proportion has been recorded for magnets, which can be particularly destructive in each location. Non specific symptoms or a complete absence of symptoms are not unusual, justifying mistaken or delayed diagnosis. Acute and chronic complications seem to occur in almost 15% of patients.

**Conclusions:** Even if an enormous heterogeneity among primary studies seems to exist and even if the absence of variables standardized definitions across case series, including class age definition and symptoms and signs descriptions, seriously impairs studies comparability, our results testify the relevant morbidity associated with foreign body inhalation in children, stressing the importance of preventive measures.

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## 1. Introduction

The inhalation/aspiration of foreign bodies (FB) into the upper airways can be a very serious event, sometimes resulting in fatal outcomes, and frequently having considerable social and economic consequences. Therefore, in scientific literature great attention has been devoted to this issue and several papers reporting single case description or detailing features of a case series have been published. Also several narrative reviews discussed more clinical

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aspects of the FB injuries, like clinical diagnosis and management of the injured child [1]. Very recently, some attempts have been made to start a systematic collection of FB in view of using them to characterize the risk of choking in terms of size, shape and consistency of the FB [2]. However, most of the epidemiologic evidence on foreign bodies in children comes from single-center retrospective studies, without any systematic geographical and temporal coverage [3–7].

Particularly, in spite of the wide interest proven by the high number of published papers on the argument, no attempts have been made to synthesize the epidemiological data as arising from the literature. This paper is an attempt aimed at filling this gap, providing an estimate of the distribution of foreign body's injuries in children according to gender, age, type of FB, site of obstruction, clinical presentation, diagnostic/therapeutic procedures, complications, as emerging from a meta-analytic review of published papers.

## 2. Materials and methods

A free text search on PubMed database ((foreign bodies) OR (foreign body)) AND ((aspiration) OR (airways) OR (tracheobronchial) OR (nasal) OR (inhalation) OR (obstruction) OR (choking) OR (inhaled) OR (aspirations) OR (nose) OR (throat) OR (asphyxiation)) AND ((children) OR (child)) finalized to identify all articles referring to foreign body inhalation over a 30 yrs period (1978–2008) was performed.

Papers' pertinence was independently evaluated by two reviewers starting from title and abstract. Papers referring to adult FB injuries, other sites of injury other than aerial tract and iatrogenic causes were excluded. Only case series were included in the analysis while case reports were excluded. Papers referring to the same series of data were included only once in the meta-analysis. Only case series written in English were included.

For each record included in the analysis, information was extracted on country, period, children sex and age, FB type, site of obstruction, symptoms, signs, diagnostic and therapeutic procedures, delay at the diagnosis, complications, number of deaths.

The target of the analysis has been defined as the proportion of injuries as reported in the studies, stratified according to children demographic characteristics, injury dynamics, type of FB, site of obstruction. Moreover, also symptoms, signs, radiological findings, removal techniques, delayed or mistaken diagnosis, complications and death have been considered and pooled proportion computed.

The pooled proportions of FB was calculated using the DerSimonian and Laird approach [8,9]. All studies with missing values or zero counts were excluded pair wise from the analysis. First, a  $\chi^2$  test for homogeneity of proportions among the different studies was performed using the Cochran method 43. Thus, the pooled proportions of FB was estimated along with the corresponding 95% confidence intervals (CI), using again the DerSimonian-Laird random effects weighting scheme for the studies included in the analysis.

All analyses have been performed using the software R 44 [10] with the rmeta package [11].

## 3. Results

According with the search strategy previously described, 1699 papers were retrieved and 1063 were judged pertinent; 214 English written case series were identified, among them 174 articles were available and have been included in the analysis. Considered references are shown in Table 1. On the whole, articles' authors observed 30,477 children suspected of having aspirated a foreign body. Pooled estimates of injury proportion are presented in Tables 2–7 stratified for relevant variables including children

and FB characteristics. For each stratum, the number of articles reporting data about the considered characteristic, the number of cases having the considered characteristic and the total number of cases described in the articles are reported. Particularly, in Table 2 injuries pooled proportions are presented stratified by children age and sex, and by injury dynamics (including adult presence and activity before accident); moreover, details regarding FB locations and FB types are presented respectively in Tables 3 and 4. In Table 5 pooled proportions of symptoms and signs are shown while in Table 6 radiographic findings and adopted removal techniques are described. Finally, in Table 7 pooled proportions of diagnostic delay, mistaken diagnosis, complication and deaths are reported.

## 4. Discussion

Taking stock of what is known in any field involves reviewing the existing literature, summarizing it in appropriate ways, and exploring the implications of heterogeneity of population and study for heterogeneity of study results. Meta-analysis provides a systematic way of performing this research synthesis, while indicating when more research is necessary. Usually, meta-analytic studies resume randomized controlled trials results, which are considered to provide the strongest evidence regarding an intervention. However, in many situations, including studies of risk factors, only data from observational studies are available and, even if the extreme diversity of study designs and populations in epidemiology could make the interpretation of simple summaries problematic, meta-analyses of observational studies continue to be one of the few methods for answering urgent questions in clinical and public health research.

Particularly, despite aspiration and inhalation of FBs are common events in paediatrics accounting for a not negligible proportion of accidental deaths in children under 4 years of age, this issue is still poorly understood and existing knowledge not yet systematically reviewed and synthesized.

Our study, in which 1063 were judged pertinent and only 174 English written case series were identified and included in the analysis, testifies that the great amount of papers about this topic are case reports typically consisting of complaints, examination findings, diagnosis, treatment and outcome; however, no hypothesis, data analysis or generalizable conclusion is possible on this base. On the other hand, the absence of variables standardized definitions across case series, including class age definition and symptoms and signs descriptions, seriously impairs studies comparability. Moreover an enormous heterogeneity among primary studies seems to exist. Despite these limitations, results obtained in the present study stress some key messages.

First of all, airway foreign body most commonly occurs in young children, almost 20% of children who have inhaled foreign bodies being between 0 and 3 years of age. Great attention is paid in scientific literature on objects causing the injury: organic FB, particularly nuts, are the most documented objects while, among inorganic FBs, the greatest pooled proportion has been recorded for magnets, which can be particularly destructive in each location. Moreover, injuries are frequently due to an incorrect manipulation of objects not conceived for children use, including pins, nails, screws, floats.

The clinical presentation of foreign body aspiration ranges from none to severe airway obstruction; cough, choking, dyspnea, reduced/abnormal breath sounds and respiratory movements decreased appear as the most documented symptoms and signs; however, non specific symptoms or a complete absence of symptoms are not unusual, therefore, clinicians may fail to consider the diagnosis of an inhaled foreign body if child shows no symptoms at presentation, especially when also chest radiograph findings are normal. Even if chest radiograph findings

**Table 1**

References considered in the meta-analysis.

Abdel-Rahman HA, 2000 [12]	Cohen SR, 1980 [13]	Keith FM, 1980 [14]	Reilly JS, 1992 [15]
Adaletli I, 2007 [16]	Das SK, 1984 [17]	Kohli GS, 1989 [18]	Righini CA, 2007 [19]
Adeyemo AO, 1986 [20]	Davies H, 1990 [21]	Lakhani JK, 1998 [22]	Roh JL, 2008 [23]
Agarwal RK, 1988 [24]	Divisi D, 2007 [25]	Lakhkar BB, 2000 [26]	Rothmann BF, 1980 [27]
Ahmed AA, 1994 [28]	Emir H, 2001 [29]	Laks Y, 1988 [30]	Rouillon I, 2006 [31]
Al-Ali MA, 2007 [32]	Endican S, 2006 [33]	Latifi X, 2006 [34]	Samad L, 1998 [35]
al-Hilou R, 1991 [6]	Eren S, 2003 [36]	Lifschultz BD, 1996 [37]	Saquist Mallick M, 2005 [38]
Alleemudder D, 2007 [39]	Erikçi V, 2003 [40]	Lima JA, 1989 [41]	Schmidt, H., 2000 [42]
Altkorn R, 2008 [43]	Esclamado RM, 1987 [44]	Linegar AG, 1992 [45]	Sehgal A, 2002 [46]
Altmann A, 1995 [47]	Even L, 2005 [48]	Loh WS, 2003 [49]	Sersar SI, 2006 [50]
Altmann AE, 1997 [51]	Fadl FA, 1997 [52]	Ludemann JP, 2007 [53]	Shah MB, 2008 [54]
Ammari FF, 2000 [55]	Fraga A, 2008 [56]	Mahafza T, 2007 [57]	Shaikholeslami V, 1978 [58]
Andazola JJ, 1999 [59]	François M, 1998 [60]	Maitra AK, 1980 [61]	Shanmugham MS, 1984 [62]
Anyanwu CH, 1985 [63]	Gaafar H, 1982 [64]	Mantel K, 1986 [65]	Sharma AK, 1992 [66]
Arjmand EM, 1997 [67]	Gatch G, 1987 [68]	Martinet A, 1997 [69]	Shivakumar AM, 2003 [70]
Asif M, 2007 [71]	Gedlu E, 1994 [72]	McCormick S, 2002 [73]	Siddiqui MA, 2000 [74]
Assefa D, 2007 [75]	Girardi G, 2004 [76]	Melaku G, 1996 [77]	Sirmali M, 2005 [78]
Aydogan LB, 2006 [79]	Glynn F, 2008 [80]	Menéndez AA, 1991 [81]	Sisenda TM, 2002 [82]
Ayed AK, 2003 [83]	Goren S, 2005 [84]	Metrangelo S, 1999 [85]	Skoulakis CE, 2000 [86]
Backlin SA, 1995 [87]	Gregori D, 2007 [88]	Midulla F, 2005 [89]	Soboczynski A, 1993 [90]
Baker MD, 1987 [91]	Gregori D, 2008 [92]	Mittleman RE, 1984 [93]	Somanath BP, 1995 [94]
Balbani AP, 1998 [95]	Gregori D, 2008 [96]	Moazam F, 1983 [97]	Soysal O, 2006 [98]
Banerjee A, 1988 [99]	Gulati SP, 2003 [100]	Monden Y, 1989 [101]	Steen KH, 1990 [102]
Barbato A, 1996 [103]	Haliloglu M, 2003 [104]	Morley RE, 2004 [105]	Stoychev S, 1980 [106]
Barrios Fontoba JE, 1997 [107]	Hamdan AL, 2000 [108]	Mu L, 1991 [109]	Swanson KL, 2002 [110]
Beg MH, 1987 [111]	Hamilton AH, 1989 [112]	Mu LC, 1990 [113]	Tan HK, 2000 [114]
Ben Amer JH, 2000 [115]	Hasdiraz L, 2006 [116]	Nandapalan V, 1994 [117]	Tander B, 2004 [118]
Bhatia PL, 1991 [119]	Heyer CM, 2006 [120]	Ngo A, 2005 [121]	Tariq P, 1999 [122]
Bittencourt PF, 2006 [123]	Higo R, 2003 [124]	Oguz F, 2000 [125]	Tiago RS, 2006 [126]
Black RE, 1994 [127]	Hoeve LJ, 1993 [128]	Oguzkaya F, 1998 [129]	Tokar B, 2004 [130]
Blazer S, 1980 [131]	Hon SK, 2001 [132]	Ogunleye AO, 2001 [3]	Tomaska M, 2006 [133]
Bloom DC, 2005 [134]	Hong SJ, 2008 [135]	Ogunleye AO, 2004 [136]	Tong MC, 1996 [137]
Bodart E, 1999 [138]	Huang HJ, 2008 [139]	Ojwang J, 1985 [140]	Ulku R, 2005 [141]
Botma M, 2000 [142]	Hussain S, 1988 [143]	Ortega M, 1986 [144]	Van Looij MA, 2003 [145]
Brkic F, 2007 [146]	Ibrahim Sersar S, 2005 [147]	Ozkurt H, 2008 [148]	Versichelen L, 1985 [149]
Burton EM, 1996 [150]	Ikeda M, 2001 [151]	Paşaoğlu I, 1991 [152]	Wiseman NE, 1984 [153]
Caglayan S, 1989 [154]	Janik JS, 1986 [155]	Papsin BC, 1994 [156]	Wolach B, 1994 [157]
Cataneo AJ, 1997 [158]	Kadish HA, 1997 [159]	Peridis S, 2009 [160]	Wood RE, 1984 [161]
Cataneo AJ, 2008 [162]	Kadmon G, 2008 [163]	Pinto A, 2006 [164]	Yadav SP, 2007 [165]
Cevizci N, 2008 [166]	Kamath P, 2006 [167]	Pinzoni F, 2007 [168]	Yagi HI, 1997 [169]
Chiu CY, 2005 [170]	Karakoc F, 2002 [171]	Poole SR, 1990 [172]	Zaytoun GM, 2000 [173]
Chung MK, 2007 [174]	Karakoc F, 2007 [175]	Puhakka H, 1989 [176]	Zerella JT, 1998 [177]
Ciftci AO, 2003 [178]	Karatzanis AD, 2007 [179]	Puterman M, 1982 [180]	
Cleatus S, 1992 [181]	Kavanagh KT, 1986 [182]	Ramírez-Figueroa JL, 2005 [183]	

**Table 2**

Injuries pooled proportions are presented stratified by demographic characteristics and injury dynamics. CI-lb: lower confidence interval bounds. CI-ub: upper confidence interval bounds. P values less than 0.05 indicate significant heterogeneity.

	Number of articles	Cases	Total number of cases (N)	Pooled-proportion	CI-lb	CI-ub	p-Value
Demographic characteristics							
Males	123	13,196	23,808	0.609	0.577	0.641	<0.001
Females	126	10,692	25,792	0.383	0.370	0.395	<0.001
Age 0–3	22	3240	4593	0.673	0.648	0.698	<0.001
Age > 3	30	2694	9495	0.254	0.216	0.292	<0.001
Injury dynamics							
Adult present	5	542	1044	0.563	0.279	0.846	<0.001
Child activity when injury occurred: playing	2	19	45	0.304	0.116	0.492	1.000
Child activity when injury occurred: eating	2	19	45	0.422	0.099	0.745	0.018

**Table 3**

Injuries pooled proportions are presented stratified by FB locations. CI-lb: lower confidence interval bounds. CI-ub: upper confidence interval bounds.

	Number of articles	Cases	Total number (N)	Pooled-proportion	CI-lb	CI-ub
Nose	21	1475	1918	0.835	0.810	0.859
Larynx	49	559	6872	0.213	0.197	0.228
Trachea	97	2458	16,923	0.157	0.147	0.168
Bronchus	113	18,366	21,164	0.882	0.871	0.893
Lung	14	407	3960	0.271	0.252	0.289
Right side	99	9788	0	0.629	0.613	0.646
Left side	96	7582	0	0.425	0.408	0.441

**Table 4**

Injuries pooled proportions are presented stratified by types of FB. CI-lb: lower confidence interval bounds. CI-ub: upper confidence interval bounds.

	Number of Articles	Cases	Total number (N)	Pooled-proportion	CI-lb	CI-ub
Organic FB						
Nuts	96	6504	18,536	0.395	0.340	0.450
Organic unspecified	55	5553	13,857	0.338	0.262	0.413
Seeds	64	3678	14,227	0.256	0.210	0.301
Unspecified food	24	421	3871	0.211	0.167	0.254
Weed/Wood	14	124	2633	0.136	0.093	0.180
Legumes	42	1406	11,058	0.107	0.084	0.131
Other food	21	266	2967	0.096	0.069	0.123
Grape	2	2	21	0.091	-0.032	0.213
Maize	14	119	2216	0.050	0.030	0.070
Bones	35	393	7417	0.049	0.037	0.060
Meat	10	112	1870	0.040	0.019	0.061
Coffee grain	5	58	1210	0.034	0.005	0.063
Carrots	14	153	4284	0.034	0.021	0.047
Popcorn	16	122	2926	0.032	0.018	0.046
Chicken	3	50	1580	0.024	0.008	0.040
Candy	6	59	2713	0.021	0.007	0.036
Apples	12	88	3920	0.020	0.013	0.027
Hotdog	6	72	2710	0.019	-0.001	0.039
Organic overall	172	19,113	29,881	0.558	0.549	0.567
Inorganic FB						
Magnet	3	13	90	0.341	-0.173	0.854
Sponge	5	42	264	0.146	0.044	0.249
Inorganic unspecified	69	2386	14,529	0.131	0.122	0.140
Other inorganic	36	751	6698	0.117	0.100	0.134
Foam	8	99	931	0.092	0.042	0.142
Battery	9	35	692	0.090	0.041	0.140
Toys	24	198	3031	0.081	0.059	0.103
Pen top	27	169	3569	0.080	0.051	0.110
Plastic pieces	54	629	8352	0.078	0.065	0.092
Pin nail tack screw	64	781	11,369	0.076	0.064	0.087
Paper	16	92	1498	0.061	0.038	0.083
Whistle	6	31	509	0.057	0.018	0.097
Button bead	19	264	3708	0.054	0.033	0.075
Coin	6	69	1560	0.050	0.021	0.080
Balls/balloon	21	87	2306	0.044	0.027	0.061
Cotton	4	18	497	0.029	0.008	0.051
Stones/shell	41	158	5210	0.027	0.020	0.035
Jewellery	12	31	1798	0.017	0.006	0.028
Pen/pencil	14	41	2933	0.011	0.006	0.015
Inorganic overall	172	5808	29,881	0.197	0.188	0.205

**Table 5**

Pooled proportions of symptoms and signs. CI-lb: lower confidence interval bounds. CI-ub: upper confidence interval bounds.

	Number of articles	Cases	Total number (N)	Pooled-proportion	CI-lb	CI-ub
Symptoms						
Cough	82	12,605	16,782	0.612	0.601	0.623
Choking	45	5947	11,680	0.468	0.353	0.583
Dyspnea	47	4507	9021	0.346	0.258	0.433
Throat pain	3	111	256	0.290	-0.035	0.614
Fever	53	1970	12,018	0.187	0.163	0.211
Toracic pain	9	43	661	0.140	0.121	0.160
Aspecific symptoms	11	147	1178	0.098	0.061	0.135
No symptoms	11	109	1327	0.079	0.046	0.111
Vomiting	11	96	1013	0.074	0.047	0.100
Voice hoarsenes	10	73	1178	0.048	0.024	0.073
Blood stained mucus	10	59	1875	0.021	0.010	0.031
Unconsciousness	3	15	1625	0.008	0.000	0.016
Signs						
Respiratory movements decreased	2	33	56	0.659	0.569	0.750
Decreased air entry	25	2672	4011	0.633	0.611	0.655
Decreased sounds	26	4262	8343	0.504	0.361	0.648
Abnormal breath sounds	78	5312	10,744	0.503	0.492	0.514
Tachypnea	15	2340	6723	0.476	0.451	0.501
Asimmetric auscultation	3	224	371	0.454	0.081	0.826
Acute Respiratory distress	10	986	3097	0.387	0.281	0.493
Nasal Flaring	5	94	395	0.340	0.189	0.491
Abnormal breath sounds wheezing	67	3152	7565	0.334	0.283	0.386
Nose pain	3	82	374	0.269	0.047	0.491
Abnormal breath sounds rhonchi	19	618	3271	0.204	0.151	0.257
Accessory muscles use	11	411	4193	0.196	0.147	0.244
Purulent discharge	8	232	1257	0.189	0.110	0.268

**Table 5** (Continued)

	Number of articles	Cases	Total number (N)	Pooled-proportion	CI-lb	CI-ub
Abnormal breath sounds rales	9	412	2536	0.183	0.120	0.246
Abnormal breath sounds stridor	44	991	7147	0.177	0.149	0.205
Odor	4	52	312	0.150	0.056	0.243
Cyanosis	41	1258	9487	0.131	0.108	0.155
Abnormal breath sounds crackles	8	139	743	0.126	0.071	0.182
Nose bleeding	11	33	854	0.023	0.009	0.037
Subcutaneous emphysema	2	5	350	0.013	0.002	0.024

**Table 6**

Pooled proportions of radiographic findings and chosen removal techniques. CI-lb: lower confidence interval bounds. CI-ub: upper confidence interval bounds.

	Number of Articles	Cases	Total Number (N)	Pooled-Proportion	CI-lb	CI-ub
<b>Radiographic findings</b>						
Normal X-ray	75	5870	16,514	0.474	0.460	0.487
Rayradiopaque.FB	74	2525	16,155	0.246	0.234	0.259
Emphysema	76	5398	14,808	0.447	0.434	0.460
Atelectasis	63	2601	15,988	0.193	0.171	0.214
Pneumonia	59	1635	13,044	0.178	0.153	0.203
Pneumothorax/Pneumomediastinum	33	415	5425	0.078	0.064	0.093
Pleural effusion	7	166	2087	0.035	0.002	0.069
Number of performed X ray	98	18,236	18,446	0.990	0.984	0.995
<b>Removal techniques</b>						
Bronchoscopy/laryngoscopy	111	19,125	19,677	0.990	0.984	0.995
Forceps	13	600	1220	0.474	0.460	0.487
Positive pressure technique	3	25	192	0.246	0.234	0.259
Surgery/thoracotomy/bronchotomy	47	479	15,153	0.447	0.434	0.460

**Table 7**

Pooled proportions of diagnostic delay, mistaken diagnosis, complication and deaths. CI-lb: lower confidence interval bounds. CI-ub: upper confidence interval.

	Number of articles	Cases	Total number (N)	Pooled-proportion	CI-lb	CI-ub
<b>Complications</b>						
Other infection	7	152	1443	0.162	0.031	0.293
Pneumonia Broncopneumonia	25	397	3605	0.106	0.084	0.127
Bronchiectasis	13	83	3742	0.096	0.053	0.140
Acteectasis	10	99	2601	0.028	0.014	0.042
Larynx edema	15	229	7874	0.025	0.016	0.033
Respiratory arrest	15	93	2886	0.024	0.013	0.035
Cardiopulmonary arrest	19	434	9683	0.020	0.011	0.030
Tracheal laceration	7	82	6156	0.006	-0.001	0.013
Lung abscess empyema	6	14	1037	0.005	-0.003	0.012
Pneumothorax/pneumomediastinum	23	56	7002	0.004	0.002	0.006
Pulmonary edema	6	8	476	0.003	0.000	0.007
Complications Overall	54	1482	13,684	0.157	0.131	0.184
<b>Mistaken diagnosis</b>						
Asthma	5	54	1205	0.231	0.183	0.279
Infections	6	221	1273	0.307	0.257	0.356
<b>Delay in diagnosis</b>						
Up to 24 h	49	3427	7625	0.470	0.452	0.488
Greater than 24 h	51	8027	11,118	0.601	0.585	0.617
Deaths	127	718	31,305	0.062	0.056	0.068

compatible with an inhaled foreign body include air trapping, atelectasis, and pneumothorax, none of these findings are pathognomonic for foreign body inhalation and in our study almost half of cases had normal radiography, while definitive diagnosis is usually performed by endoscopic evaluation.

Diagnosis of an inhaled foreign body was delayed by more than 24 h in almost 40% of cases. As frequently reported in scientific literature, delayed diagnosis of an inhaled foreign body can result in serious acute and chronic complications which seem to occur in almost 15% of patients. Particularly, pneumonia and bronchopneumonia seem to be the most frequently documented in analyzed case series.

Interestingly, while data regarding FB type are almost always reported, only a relatively small proportion of articles presents details regarding clinical presentation, diagnostic procedures and complications revealing poor attention toward the follow up of

patients after FB extraction and thus toward long terms outcomes.

Finally, only 5 article reported data regarding adult presence during injury occurrence; this fact reveals the insufficient attention paid to preventive issues by both clinicians and parents while, on the contrary, given the considerable mortality and morbidity associated with foreign body inhalation in children, the importance of preventive measures needs to be emphasized to parents and caregivers.

## References

- [1] V. Erikci, S. Karacay, A. Arıkan, Foreign body aspiration: a four-years experience, *Ulus Travma Derg.* 9 (January (1)) (2003) 45–49.
- [2] B.K. Reilly, D. Stool, X. Chen, G. Rider, S.E. Stool, J.S. Reilly, Foreign body injury in children in the twentieth century: a modern comparison to the Jackson collection, *Int. J. Pediatr. Otorhinolaryngol.* 67S1 (2003) S171–S174.



- [3] A.O. Ogunleye, O.G. Nwaorgu, O.A. Sogebi, Upper airway obstruction in Nigeria: an aetiological profile and review of the literature, *Trop. Doct.* 31 (October (4)) (2001) 195–197.
- [4] B.C. Becker, T.G. Nielsen, Foreign bodies in the airways and esophagus in children, *Ugeskr. Laeger* 156 (July (30)) (1994) 4336–4339.
- [5] J. Lao, H.E. Bostwick, S. Berezin, M.S. Halata, L.J. Newman, M.S. Medow, Esophageal food impaction in children, *Pediatr. Emerg. Care* 19 (December (6)) (2003) 402–407.
- [6] R. al-Hilou, Inhalation of foreign bodies by children: review of experience with 74 cases from Dubai, *J. Laryngol. Otol.* 105 (June (6)) (1991) 466–470.
- [7] T. Mahafza, A. Batieha, M. Suboh, T. Khrais, Esophageal foreign bodies: a Jordanian experience, *Int. J. Pediatr. Otorhinolaryngol.* 64 (July (3)) (2002) 225–227.
- [8] W. Cochran, The combination of estimates from different experiments, *Biometrics* 10 (1954) 101–129.
- [9] R. DerSimonian, L.N., Meta-analysis in clinical trials, *Control. Clin. Trials* 7 (1986) 177–188.
- [10] T. Lumley, The RMETA Package, 2003.
- [11] Team RDC, R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria, 2003.
- [12] H.A. Abdel-Rahman, Fatal suffocation by rubber balloons in children: mechanism and prevention, *Forensic Sci. Int.* 108 (February (2)) (2000) 97–105.
- [13] S.R. Cohen, W.I. Herbert, G.B. Lewis Jr., K.A. Geller, Foreign bodies in the airway. Five-year retrospective study with special reference to management, *Ann. Otol. Rhinol. Laryngol.* 89 (September–October (5 Pt 1)) (1980) 437–442.
- [14] F.M. Keith, E.J. Charrette, R.B. Lynn, T.A. Salerno, Inhalation of foreign bodies by children: a continuing challenge in management, *Can. Med. Assoc. J.* 122 (January (152)) (1980) 5–7.
- [15] J.S. Reilly, Airway foreign bodies: update and analysis, *Int. Anesthesiol. Clin.* 30 (4) (1992 Fall) 49–55.
- [16] I. Adaletli, S. Kurugoglu, S. Ulus, H. Ozer, M. Elicevik, F. Kantarci, et al., Utilization of low-dose multidetector CT and virtual bronchoscopy in children with suspected foreign body aspiration, *Pediatr. Radiol.* 37 (January (1)) (2007) 33–40.
- [17] S.K. Das, Aetiological evaluation of foreign bodies in the ear and nose, *J. Laryngol. Otol.* 98 (October (10)) (1984) 989–991.
- [18] G.S. Kohli, S.P. Yadav, J.K. Sahni, H. Goel, L. Jain, Thorny foreign bodies of upper airway, *Indian J. Chest Dis. Allied Sci.* 31 (April–June (2)) (1989) 105–108.
- [19] C.A. Righini, N. Morel, A. Karkas, E. Rey, K. Ferretti, I. Pin, et al., What is the diagnostic value of flexible bronchoscopy in the initial investigation of children with suspected foreign body aspiration? *Int. J. Pediatr. Otorhinolaryngol.* 71 (September (9)) (2007) 1383–1390.
- [20] A.O. Adeyemo, M.A. Bankole, Foreign bodies in the tracheobronchial tree: management and complications, *J. Natl. Med. Assoc.* 78 (June (6)) (1986) 511–516.
- [21] H. Davies, I. Gordon, D.J. Matthew, P. Helms, I.J. Kenney, J.E. Lutkin, et al., Long term follow up after inhalation of foreign bodies, *Arch. Dis. Child.* 65 (June (6)) (1990) 619–621.
- [22] J.K. Lakhani, Bronchial foreign bodies lateralisation in children, *Indian Pediatr.* 35 (August (8)) (1998) 798–799.
- [23] J.L. Roh, S.J. Hong, Lung recovery after rigid bronchoscopic removal of tracheobronchial foreign bodies in children, *Int. J. Pediatr. Otorhinolaryngol.* 72 (May (5)) (2008) 635–641.
- [24] R.K. Agarwal, G. Banerjee, N. Shembish, B.A. Jamal, C. Kareemullah, A. Swaleh, Foreign bodies in the tracheobronchial tree: a review of 102 cases in Benghazi, Libya, *Ann. Trop. Paediatr.* 8 (December (4)) (1988) 213–216.
- [25] D. Divisi, S. Di Tommaso, M. Garramone, W. Di Francescantonio, R.M. Crisci, A.M. Costa, et al., Foreign bodies aspirated in children: role of bronchoscopy, *Thorac. Cardiovasc. Surg.* 55 (June (4)) (2007) 249–252.
- [26] B.B. Lakhkar, P. Kini, V. Shenoy, N. Bhaskaranand, Foreign body aspiration: Manipal experience, *Indian Pediatr.* 37 (February (2)) (2000) 193–195.
- [27] B.F. Rothmann, C.R. Boeckman, Foreign bodies in the larynx and tracheobronchial tree in children. A review of 225 cases, *Ann. Otol. Rhinol. Laryngol.* 89 (September–October (5 Pt 1)) (1980) 434–436.
- [28] A.A. Ahmed, Bronchoscopic extraction of aspirated foreign bodies in children in Harare Central Hospital, Harare, Zimbabwe, *Cent. Afr. J. Med.* 40 (July (7)) (1994) 183–186.
- [29] H. Emir, G. Tekant, C. Besik, M. Elicevik, O.F. Senyuz, C. Buyukunal, et al., Bronchoscopic removal of tracheobronchial foreign bodies: value of patient history and timing, *Pediatr. Surg. Int.* 17 (March (2–3)) (2001) 85–87.
- [30] Y. Laks, Z. Barzilay, Foreign body aspiration in childhood, *Pediatr. Emerg. Care* 4 (June (2)) (1988) 102–106.
- [31] I. Rouillon, J.B. Charrier, D. Devictor, F. Portier, I.K. Lebre, P. Attal, et al., Lower respiratory tract foreign bodies: a retrospective review of morbidity, mortality and first aid management, *Int. J. Pediatr. Otorhinolaryngol.* 70 (November (11)) (2006) 1949–1955.
- [32] M.A. Al-Ali, B. Khassawneh, F. Alzoubi, Utility of fiberoptic bronchoscopy for retrieval of aspirated headscarf pins, *Respiration* 74 (3) (2007) 309–313.
- [33] S. Endican, J.P. Garap, S.P. Dubej, Ear, nose and throat foreign bodies in Melanesian children: an analysis of 1037 cases, *Int. J. Pediatr. Otorhinolaryngol.* 70 (September (9)) (2006) 1539–1545.
- [34] X. Latifi, A. Mustafa, Q. Hysenaj, Rigid tracheobronchoscopy in the management of airway foreign bodies: 10 years experience in Kosovo, *Int. J. Pediatr. Otorhinolaryngol.* 70 (December (12)) (2006) 2055–2059.
- [35] L. Samad, M. Ali, H. Ramzi, Tracheobronchial foreign bodies in children: reaching a diagnosis, *J. Pak. Med. Assoc.* 48 (November (11)) (1998) 332–334.
- [36] S. Eren, A.E. Balci, B. Dikici, M. Doblal, M.N. Eren, Foreign body aspiration in children: experience of 1160 cases, *Ann. Trop. Paediatr.* 23 (March (1)) (2003) 31–37.
- [37] B.D. Lifschultz, E.R. Donoghue, Deaths due to foreign body aspiration in children: the continuing hazard of toy balloons, *J. Forensic Sci.* 41 (March (2)) (1996) 247–251.
- [38] M. Saquib Mallick, A. Rauf Khan, A. Al-Bassam, Late presentation of tracheobronchial foreign body aspiration in children, *J. Trop. Pediatr.* 51 (June (3)) (2005) 145–148.
- [39] D. Alleemudder, A. Sonsale, S. Ali, Positive pressure technique for removal of nasal foreign bodies, *Int. J. Pediatr. Otorhinolaryngol.* 71 (November (11)) (2007) 1809–1811.
- [40] V. Eriksi, S. Karacay, A. Arikani, Foreign body aspiration: a four-years experience, *Ulus Travma Acil Cerrahi Derg.* 9 (January (1)) (2003) 45–49.
- [41] J.A. Lima, Laryngeal foreign bodies in children: a persistent, life-threatening problem, *Laryngoscope* 99 (April (4)) (1989) 415–420.
- [42] H. Schmidt, B.C. Manegold, Foreign body aspiration in children, *Surg. Endosc.* 14 (July (7)) (2000) 644–648.
- [43] R. Altkorn, X. Chen, S. Milkovich, D. Stool, G. Rider, C.M. Bailey, et al., Fatal and non-fatal food injuries among children (aged 0–14 years), *Int. J. Pediatr. Otorhinolaryngol.* 72 (July (7)) (2008) 1041–1046.
- [44] R.M. Esclamado, M.A. Richardson, Laryngotracheal foreign bodies in children. A comparison with bronchial foreign bodies, *Am. J. Dis. Child.* 141 (March (3)) (1987) 259–262.
- [45] A.G. Linegar, U.O. von Oppell, S. Hegemann, M. de Groot, J.A. Odell, Tracheobronchial foreign bodies. Experience at Red Cross Children's Hospital, 1985–1990, *S. Afr. Med. J.* 82 (September (3)) (1992) 164–167.
- [46] A. Sehgal, V. Singh, J. Chandra, N.N. Mathur, Foreign body aspiration, *Indian Pediatr.* 39 (November (11)) (2002) 1006–1010.
- [47] A. Altmann, T. Nolan, Non-intentional asphyxiation deaths due to upper airway interference in children 0 to 14 years, *Inj. Prev.* 1 (June (2)) (1995) 76–80.
- [48] L. Even, N. Heno, Y. Talmon, E. Samet, Z. Zonis, A. Kugelman, Diagnostic evaluation of foreign body aspiration in children: a prospective study, *J. Pediatr. Surg.* 40 (July (7)) (2005) 1122–1127.
- [49] W.S. Loh, J.L. Leong, H.K. Tan, Hazardous foreign bodies: complications and management of button batteries in nose, *Ann. Otol. Rhinol. Laryngol.* 112 (April (4)) (2003) 379–383.
- [50] S.I. Sersar, W.H. Rizk, M. Bilal, M.M. El Diasty, T.A. Eltantawy, B.B. Abdelhakam, et al., Inhaled foreign bodies: presentation, management and value of history and plain chest radiography in delayed presentation, *Otolaryngol. Head Neck Surg.* 134 (January (1)) (2006) 92–99.
- [51] A.E. Altmann, J. Ozanne-Smith, Non-fatal asphyxiation and foreign body ingestion in children 0–14 years, *Inj. Prev.* 3 (September (3)) (1997) 176–182.
- [52] F.A. Fadl, M.I. Omer, Tracheobronchial foreign bodies: a review of children admitted for bronchoscopy at King Fahd Specialist Hospital, Al Gassim, Saudi Arabia, *Ann. Trop. Paediatr.* 17 (December (4)) (1997) 309–313.
- [53] J.P. Ludemann, K.H. Riding, Choking on pins, needles and a blowdart: aspiration of sharp, metallic foreign bodies secondary to careless behavior in seven adolescents, *Int. J. Pediatr. Otorhinolaryngol.* 71 (February (2)) (2007) 307–310.
- [54] M.B. Shah, J.P. Bent, A.G. Vicencio, H. Veler, R. Arens, S.R. Parikh, Flexible bronchoscopy and interdisciplinary collaboration in pediatric large airway disease, *Int. J. Pediatr. Otorhinolaryngol.* 72 (December (12)) (2008) 1771–1776.
- [55] F.F. Ammari, K.T. Faris, T.M. Mahafza, Inhalation of wild barley into the airways: two different outcomes, *Saudi Med. J.* 21 (May (5)) (2000) 468–470.
- [56] M. Fraga Ade, M.C. Reis, M.P. Zambon, I.C. Toro, J.D. Ribeiro, E.C. Baracat, Foreign body aspiration in children: clinical aspects, radiological aspects and bronchoscopic treatment, *J. Bras. Pneumol.* 34 (February (2)) (2008) 74–82.
- [57] T. Mahafza, Y. Khader, Aspirated tracheobronchial foreign bodies: a Jordanian experience, *Ear. Nose. Throat J.* 86 (February (2)) (2007) 107–110.
- [58] V. Shaikholeslami, Anaesthesia in bronchoscopy removal of inhaled bodies. Report of 173 cases, *Acta Med. Iran.* 21 (1) (1978) 47–51.
- [59] J.J. Andazola, R.E. Sapien, The choking child: what happens before the ambulance arrives? *Prehosp. Emerg. Care* 3 (January–March (1)) (1999) 7–10.
- [60] M. Francois, R. Hamrioui, P. Narcy, Nasal foreign bodies in children, *Eur. Arch. Otorhinolaryngol.* 255 (3) (1998) 132–134.
- [61] A.K. Maitra, Casualty experience of swallowed foreign body, *Br. J. Clin. Pract.* 34 (January (115–117)) (1980) 24.
- [62] M.S. Shanmugham, The incidence of inhaled foreign body in West Malaysia, *Singapore Med. J.* 25 (February (1)) (1984) 52–53.
- [63] C.H. Anyanwu, Foreign body airway obstruction in Nigerian children, *J. Trop. Pediatr.* 31 (June (3)) (1985) 170–173.
- [64] H. Gaafar, M. Abdel-Dayem, M. Talaat, M. Mandour, The value of X-ray examination in the diagnosis of tracheobronchial foreign bodies in infants and children, *ORL J. Otorhinolaryngol. Relat. Spec.* 44 (6) (1982) 340–348.
- [65] K. Mantel, I. Butenandt, Tracheobronchial foreign body aspiration in childhood. A report on 224 cases, *Eur. J. Pediatr.* 145 (August (3)) (1986) 211–216.
- [66] A.K. Sharma, L.D. Agarwal, G. Prabhakar, A. Gupta, C. Sharma, S. Chandra, Therapeutic and diagnostic role of bronchoscopy in pediatric age group, *Indian Pediatr.* 29 (March (3)) (1992) 287–290.
- [67] E.M. Arjmand, H.R. Muntz, S.L. Stratmann, Insurance status as a risk factor for foreign body ingestion or aspiration, *Int. J. Pediatr. Otorhinolaryngol.* 42 (October (1)) (1997) 25–29.
- [68] G. Gatch, L. Myre, R.E. Black, Foreign body aspiration in children. Causes, diagnosis, and prevention, *AORN J.* 46 (November (5)) (1987) 850–861.
- [69] A. Martinot, M. Closset, C.H. Marquette, V. Hue, A. Deschildre, P. Ramon, et al., Indications for flexible versus rigid bronchoscopy in children with suspected

- foreign-body aspiration, *Am. J. Respir. Crit. Care Med.* 155 (May (5)) (1997) 1676–1679.
- [70] A.M. Shivakumar, A.S. Naik, K.B. Prashanth, K.D. Shetty, D.S. Praveen, Tracheobronchial foreign bodies, *Indian J. Pediatr.* 70 (October (10)) (2003) 793–797.
- [71] M. Asif, S.A. Shah, F. Khan, R. Ghani, Analysis of tracheobronchial foreign bodies with respect to sex, age, type and presentation, *J. Ayub Med Coll Abbottabad.* 19 (January–March (1)) (2007) 13–15.
- [72] E. Gedlu, Accidental injuries among children in north-west Ethiopia, *East Afr. Med. J.* 71 (December (12)) (1994) 807–810.
- [73] S. McCormick, P. Brennan, J. Yassa, R. Shawis, Children and mini-magnets: an almost fatal attraction, *Emerg. Med. J.* 19 (January (1)) (2002) 71–73.
- [74] M.A. Siddiqui, A.H. Banjar, S.M. Al-Najjar, M.M. Al-Fattani, M.F. Aly, Frequency of tracheobronchial foreign bodies in children and adolescents, *Saudi Med. J.* 21 (April (4)) (2000) 368–371.
- [75] D. Assefa, N. Amin, G. Stringel, A.J. Dozor, Use of decubitus radiographs in the diagnosis of foreign body aspiration in young children, *Pediatr. Emerg. Care* 23 (March (3)) (2007) 154–157.
- [76] G. Girardi, A.M. Contador, J.A. Castro-Rodriguez, Two new radiological findings to improve the diagnosis of bronchial foreign-body aspiration in children, *Pediatr. Pulmonol.* 38 (September (3)) (2004) 261–264.
- [77] G. Melaku, Foreign body aspiration in children: experience from Ethiopia, *East Afr. Med. J.* 73 (July (7)) (1996) 459–462.
- [78] M. Sirmali, H. Turut, E. Kisacik, G. Findik, S. Kaya, I. Tastepe, The relationship between time of admittance and complications in paediatric tracheobronchial foreign body aspiration, *Acta Chir. Belg.* 105 (November–December (6)) (2005) 631–634.
- [79] L.B. Aydogan, U. Tuncer, L. Soyulu, M. Kiroglu, C. Ozsahinoglu, Rigid bronchoscopy for the suspicion of foreign body in the airway, *Int. J. Pediatr. Otorhinolaryngol.* 70 (May (5)) (2006) 823–828.
- [80] F. Glynn, M. Amin, J. Kinsella, Nasal foreign bodies in children: should they have a plain radiograph in the accident and emergency? *Pediatr. Emerg. Care* 24 (April (4)) (2008) 217–218.
- [81] A.A. Menendez, F. Gotay Cruz, F.J. Seda, W. Velez, J. Trinidad Pinedo, Foreign body aspiration: experience at the University Pediatric Hospital, *P. R. Health Sci. J.* 10 (December (3)) (1991) 127–133.
- [82] T.M. Sisenda, B.O. Khwa-Otsyula, J.O. Wambani, Management of tracheo-bronchial foreign bodies in children, *East Afr. Med. J.* 79 (November (11)) (2002) 580–583.
- [83] A.K. Aayed, A.M. Jafar, A. Owayed, Foreign body aspiration in children: diagnosis and treatment, *Pediatr. Surg. Int.* 19 (August (6)) (2003) 485–488.
- [84] S. Goren, F. Gurkan, Y. Tirasci, Z. Kaya, K. Acar, Foreign body asphyxiation in children, *Indian Pediatr.* 42 (November (11)) (2005) 1131–1133.
- [85] S. Metrangolo, C. Monetti, L. Meneghini, N. Zadra, F. Giusti, Eight years' experience with foreign-body aspiration in children: what is really important for a timely diagnosis? *J. Pediatr. Surg.* 34 (August (8)) (1999) 1229–1231.
- [86] C.E. Skoulakis, P.G. Doxas, C.E. Papadakis, E. Proimos, P. Christodoulou, J.G. Bizakis, et al., Bronchoscopy for foreign body removal in children. A review and analysis of 210 cases, *Int. J. Pediatr. Otorhinolaryngol.* 53 (June (2)) (2000) 143–148.
- [87] S.A. Backlin, Positive-pressure technique for nasal foreign body removal in children, *Ann. Emerg. Med.* 25 (April (4)) (1995) 554–555.
- [88] D. Gregori, B. Morra, S. Snidero, C. Scarinzi, G.C. Passali, A. Rinaldi Ceroni, et al., Foreign bodies in the upper airways: the experience of two Italian hospitals, *J. Prev. Med. Hyg.* 48 (March (1)) (2007) 24–26.
- [89] F. Midulla, R. Guidi, A. Barbato, P. Capocaccia, N. Forenza, G. Marseglia, et al., Foreign body aspiration in children, *Pediatr. Int.* 47 (December (6)) (2005) 663–668.
- [90] A. Sobocznyski, A. Skuratowicz, M. Grzegorowski, I. Chwirot-Glyda, The problem of lower respiratory tract foreign bodies in children, *Acta Otorhinolaryngol. Belg.* 47 (4) (1993) 443–447.
- [91] M.D. Baker, Foreign bodies of the ears and nose in childhood, *Pediatr. Emerg. Care* 3 (June (2)) (1987) 67–70.
- [92] D. Gregori, L. Salerni, C. Scarinzi, B. Morra, P. Berchiolla, S. Snidero, et al., Foreign bodies in the upper airways causing complications and requiring hospitalization in children aged 0–14 years: results from the ESFB study, *Eur. Arch. Otorhinolaryngol.* 265 (August (8)) (2008) 971–978.
- [93] R.E. Mittleman, Fatal choking in infants and children, *Am. J. Forensic Med. Pathol.* 5 (September (3)) (1984) 201–210.
- [94] B.P. Somanath, S. Singhi, Airway foreign bodies in children, *Indian Pediatr.* 32 (August (8)) (1995) 890–897.
- [95] A.P. Balbani, T.G. Sanchez, O. Butugan, M.A. Kii, F.V. Angelico Jr., C.M. Ikin, et al., Ear and nose foreign body removal in children, *Int. J. Pediatr. Otorhinolaryngol.* 46 (November (1–2)) (1998) 37–42.
- [96] D. Gregori, L. Salerni, C. Scarinzi, B. Morra, P. Berchiolla, S. Snidero, et al., Foreign bodies in the nose causing complications and requiring hospitalization in children 0–14 age: results from the European survey of foreign bodies injuries study, *Rhinology* 46 (March (1)) (2008) 28–33.
- [97] F. Moazzam, J.L. Talbert, B.M. Rodgers, Foreign bodies in the pediatric tracheo-bronchial tree, *Clin. Pediatr. (Phila.)* 22 (February (2)) (1983) 148–150.
- [98] O. Soysal, A. Kuzucu, H. Ulutas, Tracheobronchial foreign body aspiration: a continuing challenge, *Otolaryngol. Head Neck Surg.* 135 (August (2)) (2006) 223–226.
- [99] A. Banerjee, K.S. Rao, S.K. Khanna, P.S. Narayanan, B.K. Gupta, J.C. Sekar, et al., Laryngo-tracheo-bronchial foreign bodies in children, *J. Laryngol. Otol.* 102 (November (11)) (1988) 1029–1032.
- [100] S.P. Gulati, A. Kumar, A. Sachdeva, S. Arora, Groundnut as the commonest foreign body of tracheobronchial tree in winter in Northern India. An analysis of fourteen cases, *Indian J. Med. Sci.* 57 (June (6)) (2003) 244–248.
- [101] Y. Monden, T. Morimoto, T. Taniiki, T. Uyama, S. Kimura, Flexible bronchoscopy for foreign body in airway, *Tokushima J. Exp. Med.* 36 (June (1–2)) (1989) 35–39.
- [102] K.H. Steen, T. Zimmermann, Tracheobronchial aspiration of foreign bodies in children: a study of 94 cases, *Laryngoscope* 100 (May (5)) (1990) 525–530.
- [103] A. Barbato, A. Novello Jr., F. Tormena, P. Corner, Problems with the retrieval of long-standing inhaled foreign bodies in children, *Monaldi Arch. Chest Dis.* 51 (October (5)) (1996) 419–420.
- [104] M. Haliloglu, A.O. Gifci, A. Oto, B. Gumus, F.C. Tanyel, M.E. Senocak, et al., CT virtual bronchoscopy in the evaluation of children with suspected foreign body aspiration, *Eur. J. Radiol.* 48 (November (2)) (2003) 188–192.
- [105] R.E. Morley, J.P. Ludemann, J.P. Moxham, F.K. Kozak, K.H. Riding, Foreign body aspiration in infants and toddlers: recent trends in British Columbia, *J. Otolaryngol.* 33 (February (1)) (2004) 37–41.
- [106] S. Stoychev, A. Gulev, Clinical study of foreign metal bodies in the airways, *Folia Med. (Plovdiv)* 22 (3) (1980) 19–21.
- [107] J.E. Barrios Fontoba, C. Gutierrez, J. Lluna, J.J. Vila, J. Poquet, S. Ruiz-Company, Bronchial foreign body: should bronchoscopy be performed in all patients with a choking crisis? *Pediatr. Surg. Int.* 12 (February (2–3)) (1997) 118–120.
- [108] A.L. Hamdan, S.M. Mroueh, F.F. Bitar, F.T. Farhat, Foreign body retrieval in children with respiratory symptoms and no history of aspiration, *Middle East J. Anesthesiol.* 15 (October (6)) (2000) 673–680.
- [109] L. Mu, P. He, D. Sun, Inhalation of foreign bodies in Chinese children: a review of 400 cases, *Laryngoscope* 101 (June (6 Pt 1)) (1991) 657–660.
- [110] K.L. Swanson, U.B. Prakash, D.E. Midhun, E.S. Edell, J.P. Utz, J.C. McDougall, et al., Flexible bronchoscopic management of airway foreign bodies in children, *Chest* 121 (May (5)) (2002) 1695–1700.
- [111] M.H. Beg, Reyazuddin, A. Hasan, Inhaled foreign bodies, *Indian Pediatr.* 24 (July (7)) (1987) 583–585.
- [112] A.H. Hamilton, F. Carswell, J.D. Wisheart, The Bristol Children's Hospital experience of tracheobronchial foreign bodies 1977–87, *Bristol Med. Chir. J.* 104 (August (3)) (1989) 72–74.
- [113] L.C. Mu, D.Q. Sun, P. He, Radiological diagnosis of aspirated foreign bodies in children: review of 343 cases, *J. Laryngol. Otol.* 104 (October (10)) (1990) 778–782.
- [114] H.K. Tan, K. Brown, T. McGill, M.A. Kenna, D.P. Lund, G.B. Healy, Airway foreign bodies (FB): a 10-year review, *Int. J. Pediatr. Otorhinolaryngol.* 56 (December (2)) (2000) 91–99.
- [115] J.H. Ben Amer, C. Kareemullah, M.H. Ben Amer, A. Shembish, Tracheobronchial foreign bodies in children, *Saudi Med. J.* 21 (July (7)) (2000) 672–674.
- [116] L. Hasdiraz, F. Oguzkaya, M. Bilgin, C. Bicer, Complications of bronchoscopy for foreign body removal: experience in 1,035 cases, *Ann. Saudi Med.* 26 (July–August (4)) (2006) 283–287.
- [117] V. Nandapalan, J.C. McIlwain, Removal of nasal foreign bodies with a Fogarty biliary balloon catheter, *J. Laryngol. Otol.* 108 (September (9)) (1994) 758–760.
- [118] B. Tander, B. Kirdar, E. Ariturk, R. Rizalar, F. Bernay, Why nut? The aspiration of hazelnuts has become a public health problem among small children in the central and eastern Black Sea regions of Turkey, *Pediatr. Surg. Int.* 20 (July (7)) (2004) 502–504.
- [119] P.L. Bhatia, Problems in the management of aspirated foreign bodies, *West Afr. J. Med.* 10 (April–June (2)) (1991) 158–167.
- [120] C.M. Heyer, M.E. Bollmeier, L. Rossler, T.G. Nuesslein, V. Stephan, T.T. Bauer, et al., Evaluation of clinical, radiologic, and laboratory prebronchoscopy findings in children with suspected foreign body aspiration, *J. Pediatr. Surg.* 41 (November (11)) (2006) 1882–1888.
- [121] A. Ngo, K.C. Ng, T.P. Sim, Otorhinolaryngeal foreign bodies in children presenting to the emergency department, *Singapore Med. J.* 46 (April (4)) (2005) 172–178.
- [122] P. Tariq, Foreign body aspiration in children—a persistent problem, *J. Pak. Med. Assoc.* 49 (February (2)) (1999) 33–36.
- [123] P.F. Bittencourt, P.A. Camargos, P. Scheinmann, J. de Blic, Foreign body aspiration: clinical, radiological findings and factors associated with its late removal, *Int. J. Pediatr. Otorhinolaryngol.* 70 (May (5)) (2006) 879–884.
- [124] R. Higo, Y. Matsumoto, K. Ichimura, K. Kaga, Foreign bodies in the aerodigestive tract in pediatric patients, *Auris, Nasus, Larynx* 30 (December (4)) (2003) 397–401.
- [125] F. Oguz, A. Citak, E. Unuvar, M. Sidal, Airway foreign bodies in childhood, *Int. J. Pediatr. Otorhinolaryngol.* 52 (January (1)) (2000) 11–16.
- [126] R.S. Tiago, D.C. Salgado, J.P. Correa, M.R. Pio, E.E. Lambert, Foreign body in ear, nose and oropharynx: experience from a tertiary hospital, *Braz. J. Otorhinolaryngol.* 72 (March–April (2)) (2006) 177–181.
- [127] R.E. Black, D.G. Johnson, M.E. Matlak, Bronchoscopic removal of aspirated foreign bodies in children, *J. Pediatr. Surg.* 29 (May (5)) (1994) 682–684.
- [128] L.J. Hoeve, J. Rombout, D.J. Pot, Foreign body aspiration in children. The diagnostic value of signs, symptoms and pre-operative examination, *Clin. Otolaryngol. Allied Sci.* 18 (February (1)) (1993) 55–57.
- [129] F. Oguzkaya, Y. Akcali, C. Kahraman, M. Bilgin, A. Sahin, Tracheobronchial foreign body aspirations in childhood: a 10-year experience, *Eur. J. Cardiothorac. Surg.* 14 (October (4)) (1998) 388–392.
- [130] B. Tokar, R. Ozkan, H. Ilhan, Tracheobronchial foreign bodies in children: importance of accurate history and plain chest radiography in delayed presentation, *Clin. Radiol.* 59 (July (7)) (2004) 609–615.
- [131] S. Blazer, Y. Naveh, A. Friedman, Foreign body in the airway. A review of 200 cases, *Am. J. Dis. Child.* 134 (January (1)) (1980) 68–71.

- [132] S.K. Hon, T.M. Izam, C.B. Koay, A. Razi, A prospective evaluation of foreign bodies presenting to the Ear, Nose and Throat Clinic, Hospital Kuala Lumpur, *Med. J. Malaysia* 56 (December (4)) (2001) 463–470.
- [133] M. Tomaszke, A.C. Gerber, S. Stocker, M. Weiss, Tracheobronchial foreign body aspiration in children – diagnostic value of symptoms and signs, *Swiss Med. Wkly.* 136 (August (33–34)) (2006) 533–538.
- [134] D.C. Bloom, T.E. Christenson, S.C. Manning, E.C. Eksteen, J.A. Perkins, A.F. Inglis, et al., Plastic laryngeal foreign bodies in children: a diagnostic challenge, *Int. J. Pediatr. Otorhinolaryngol.* 69 (May (5)) (2005) 657–662.
- [135] S.J. Hong, H.W. Goo, J.L. Roh, Utility of spiral and cine CT scans in pediatric patients suspected of aspirating radiolucent foreign bodies, *Otolaryngol. Head Neck Surg.* 138 (May (5)) (2008) 576–580.
- [136] A.O. Ogunleye, O.A. Sogebi, Nasal foreign bodies in the African children, *Afr. J. Med. Med. Sci.* 33 (September (3)) (2004) 225–228.
- [137] M.C. Tong, S.Y. Ying, C.A. van Hasselt, Nasal foreign bodies in children, *Int. J. Pediatr. Otorhinolaryngol.* 35 (May (3)) (1996) 207–211.
- [138] E. Bodart, G. de Bilderling, D. Tuerlinckx, J.B. Gillet, Foreign body aspiration in childhood: management algorithm, *Eur. J. Emerg. Med.* 6 (March (1)) (1999) 21–25.
- [139] H.J. Huang, H.Y. Fang, H.C. Chen, C.Y. Wu, C.Y. Cheng, C.L. Chang, Three-dimensional computed tomography for detection of tracheobronchial foreign body aspiration in children, *Pediatr. Surg. Int.* 24 (February (2)) (2008) 157–160.
- [140] J. Ojwang, E.M. Wafula, The experience of foreign body inhalation among children at Kenyatta National Hospital over a five-year-period, *East Afr. Med. J.* 62 (May (5)) (1985) 323–331.
- [141] R. Ulku, A. Onen, S. Onat, C. Ozcelik, The value of open surgical approaches for aspirated pen caps, *J. Pediatr. Surg.* 40 (November (11)) (2005) 1780–1783.
- [142] M. Botma, R. Bader, H. Kubba, 'A parent's kiss': evaluating an unusual method for removing nasal foreign bodies in children, *J. Laryngol. Otol.* 114 (August (8)) (2000) 598–600.
- [143] S. Hussain, R. Pirzada, I.H. Rizvi, S.I. Ali, Radiological findings in tracheo-bronchial foreign body aspiration, *J. Pak. Med. Assoc.* 38 (December (12)) (1988) 328–329.
- [144] M. Ortega, J.E. Sifontes, O. Rosa, P.M. Mayol, R. Rivera, Foreign body aspiration in Puerto Rican children: report of 83 cases, *Bol. Asoc. Med. P. R.* 78 (July (7)) (1986) 282–286.
- [145] M.A. Van Looij, P.P. Rood, L.J. Hoeve, J.A. Borgstein, Aspirated foreign bodies in children: why are they more commonly found on the left? *Clin. Otolaryngol. Allied Sci.* 28 (August (4)) (2003) 364–367.
- [146] F. Brkic, S. Umihanic, Tracheobronchial foreign bodies in children. Experience at ORL clinic Tuzla, 1954–2004, *Int. J. Pediatr. Otorhinolaryngol.* 71 (June (6)) (2007) 909–915.
- [147] S. Ibrahim Sersar, U.A. Hamza, W.A. AbdelHameed, R.A. AbulMaaty, N.N. Gowaeli, S.A. Moussa, et al., Inhaled foreign bodies: management according to early or late presentation, *Eur. J. Cardiothorac. Surg.* 28 (September (3)) (2005) 369–374.
- [148] H. Ozkurt, E. Bahadir, A. Ucgul, C. Altuna, M. Basak, N.M. Cevzici, et al., Comparison of multidetector computed tomography-virtual bronchoscopy and conventional bronchoscopy in children with suspected foreign body aspiration, *Emerg. Radiol.* (2008), November.
- [149] L. Versichelen, L. Herregods, R. Donadoni, H. Vermeersch, Anesthesia for foreign bodies in the tracheo-bronchial tree in children, *Acta Anaesthesiol. Belg.* 36 (September (3)) (1985) 222–229.
- [150] E.M. Burton, W.G. Brick, J.D. Hall, W. Riggs Jr., C.S. Houston, Tracheobronchial foreign body aspiration in children, *South. Med. J.* 89 (February (2)) (1996) 195–198.
- [151] M. Ikeda, K. Himi, Y. Yamauchi, A. Ikui, S. Shigihara, A. Kida, Use of digital subtraction fluoroscopy to diagnose radiolucent aspirated foreign bodies in infants and children, *Int. J. Pediatr. Otorhinolaryngol.* 61 (December (3)) (2001) 233–242.
- [152] I. Pasaoglu, R. Dogan, M. Demircin, A. Hatipoglu, A.Y. Bozer, Bronchoscopic removal of foreign bodies in children: retrospective analysis of 822 cases, *Thorac. Cardiovasc. Surg.* 39 (April (2)) (1991) 95–98.
- [153] N.E. Wiseman, The diagnosis of foreign body aspiration in childhood, *J. Pediatr. Surg.* 19 (October (5)) (1984) 531–535.
- [154] S. Caglayan, S. Erkin, I. Cotelci, H. Oniz, Bronchial foreign body vs asthma, *Chest* 96 (September (3)) (1989) 509–511.
- [155] J.S. Janik, J.D. Burrington, E.R. Wayne, J.H. Chang, T. Beach, Foreign body aspiration in children, *Colo. Med.* 83 (January (1)) (1986) 10–11.
- [156] B.C. Papsin, J. Friedberg, Aerodigestive-tract foreign bodies in children: pitfalls in management, *J. Otolaryngol.* 23 (April (2)) (1994) 102–108.
- [157] B. Wolach, A. Raz, J. Weinberg, Y. Mikulski, J. Ben Ari, N. Sadan, Aspirated foreign bodies in the respiratory tract of children: eleven years experience with 127 patients, *Int. J. Pediatr. Otorhinolaryngol.* 30 (July (1)) (1994) 1–10.
- [158] A.J. Cataneo, S.M. Reibscheld, R.L. Ruiz Junior, G.F. Ferrari, Foreign body in the tracheobronchial tree, *Clin. Pediatr. (Phila.)* 36 (December (12)) (1997) 701–706.
- [159] H.A. Kadish, H.M. Corneli, Removal of nasal foreign bodies in the pediatric population, *Am. J. Emerg. Med.* 15 (January (1)) (1997) 54–56.
- [160] S. Peridis, I. Athanasopoulos, M. Salamoura, K. Parpounas, E. Koudoumnakis, J. Economides, Foreign bodies of the ear and nose in children and its correlation with right or left handed children, *Int. J. Pediatr. Otorhinolaryngol.* 73 (February (2)) (2009) 205–208.
- [161] R.E. Wood, M.W. Gauderer, Flexible fiberoptic bronchoscopy in the management of tracheobronchial foreign bodies in children: the value of a combined approach with open tube bronchoscopy, *J. Pediatr. Surg.* 19 (December (6)) (1984) 693–698.
- [162] A.J. Cataneo, D.C. Cataneo, R.L. Ruiz Jr., Management of tracheobronchial foreign body in children, *Pediatr. Surg. Int.* 24 (February (2)) (2008) 151–156.
- [163] G. Kadmon, Y. Stern, E. Bron-Harlev, E. Nahum, E. Battat, T. Schonfeld, Computerized scoring system for the diagnosis of foreign body aspiration in children, *Ann. Otol. Rhinol. Laryngol.* 117 (November (11)) (2008) 839–843.
- [164] A. Pinto, M. Scaglione, F. Pinto, G. Guidi, M. Pepe, B. Del Prato, et al., Tracheobronchial aspiration of foreign bodies: current indications for emergency plain chest radiography, *Radiol. Med.* 111 (June (4)) (2006) 497–506.
- [165] S.P. Yadav, J. Singh, N. Aggarwal, A. Goel, Airway foreign bodies in children: experience of 132 cases, *Singapore Med. J.* 48 (September (9)) (2007) 850–853.
- [166] N. Cevzici, A.I. Dokucu, D. Baskin, C.A. Karadag, N. Sever, M. Yalcin, et al., Virtual bronchoscopy as a dynamic modality in the diagnosis and treatment of suspected foreign body aspiration, *Eur. J. Pediatr. Surg.* 18 (December (6)) (2008) 398–401.
- [167] P. Kamath, K.M. Bhojwani, T. Prasannaraj, K. Abhijith, Foreign bodies in the aerodigestive tract—a clinical study of cases in the coastal belt of South India, *Am. J. Otolaryngol.* 27 (November–December (6)) (2006) 373–377.
- [168] F. Pinzoni, C. Boniotti, S.M. Molinaro, A. Baraldi, M. Berlucchi, Inhaled foreign bodies in pediatric patients: review of personal experience, *Int. J. Pediatr. Otorhinolaryngol.* 71 (Dec (12)) (2007) 1897–1903.
- [169] H.I. Yagi, Foreign bodies in the tracheobronchial tree in Sudanese patients, *J. R. Coll. Surg. Edinb.* 42 (August (4)) (1997) 235–237.
- [170] C.Y. Chiu, K.S. Wong, S.H. Lai, S.H. Hsia, C.T. Wu, Factors predicting early diagnosis of foreign body aspiration in children, *Pediatr. Emerg. Care* 21 (March (3)) (2005) 161–164.
- [171] F. Karakoc, B. Karadag, C. Akbenlioglu, R. Ersu, B. Yildizeli, M. Yuksel, et al., Foreign body aspiration: what is the outcome? *Pediatr. Pulmonol.* 34 (July (1)) (2002) 30–36.
- [172] S.R. Poole, R.D. Mauro, L.L. Fan, J. Brooks, The child with simultaneous stridor and wheezing, *Pediatr. Emerg. Care* 6 (March (1)) (1990) 33–37.
- [173] G.M. Zaytoun, P.W. Rouadi, D.H. Baki, Endoscopic management of foreign bodies in the tracheobronchial tree: predictive factors for complications, *Otolaryngol. Head Neck Surg.* 123 (September (3)) (2000) 311–316.
- [174] M.K. Chung, H.S. Jeong, K.M. Ahn, S.H. Park, J.K. Cho, Y.I. Son, et al., Pulmonary recovery after rigid bronchoscopic retrieval of airway foreign body, *Laryngoscope* 117 (February (2)) (2007) 303–307.
- [175] F. Karakoc, E. Cakir, R. Ersu, Z.S. Uyan, B. Colak, B. Karadag, et al., Late diagnosis of foreign body aspiration in children with chronic respiratory symptoms, *Int. J. Pediatr. Otorhinolaryngol.* 71 (February (2)) (2007) 241–246.
- [176] H. Puhakka, E. Svedstrom, P. Kero, P. Valli, E. Iisalo, Tracheobronchial foreign bodies. A persistent problem in pediatric patients, *Am. J. Dis. Child.* 143 (May (5)) (1989) 543–545.
- [177] J.T. Zerella, M. Dimler, L.C. McGill, K.J. Pippus, Foreign body aspiration in children: value of radiography and complications of bronchoscopy, *J. Pediatr. Surg.* 33 (November (11)) (1998) 1651–1654.
- [178] A.O. Ciftci, M. Bingol-Kologlu, M.E. Senocak, F.C. Tanyel, N. Buyukpamukcu, Bronchoscopy for evaluation of foreign body aspiration in children, *J. Pediatr. Surg.* 38 (August (8)) (2003) 1170–1176.
- [179] A.D. Karatzanis, A. Vardouniotis, J. Moschandreas, E.P. Prokopakis, E. Michailidou, C. Papadakis, et al., The risk of foreign body aspiration in children can be reduced with proper education of the general population, *Int. J. Pediatr. Otorhinolaryngol.* 71 (February (2)) (2007) 311–315.
- [180] M. Puterman, R. Gorodischer, A. Leiberman, Tracheobronchial foreign bodies: the impact of a postgraduate educational program on diagnosis, morbidity, and treatment, *Pediatrics* 70 (July (1)) (1982) 96–98.
- [181] S. Cleatus, I. Mohan, R. Ahmed, Tracheobronchial foreign bodies and pulmonary atelectasis in children, *Ann. Saudi Med.* 12 (November (6)) (1992) 582–583.
- [182] K.T. Kavanagh, T. Litovitz, Miniature battery foreign bodies in auditory and nasal cavities, *JAMA* 255 (March (11)) (1986) 1470–1472.
- [183] J.L. Ramirez-Figueroa, L.G. Gochicoa-Rangel, D.H. Ramirez-San Juan, M.H. Vargas, Foreign body removal by flexible fiberoptic bronchoscopy in infants and children, *Pediatr. Pulmonol.* 40 (November (5)) (2005) 392–397.