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Tracheobronchial Foreign Bodies in Children: 67-year experience at ENT Clinic Tuzla

Review paper

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Abstract

To evaluate clinical characteristics and outcomes of urgent bronchoscopies due to foreign body aspiration (FBA), we analyzed cases from January 1954 to December 2021. The study included children up to 14 years of age who underwent emergency bronchoscopy on suspicion of a foreign body in the lower respiratory tract. Each patient was assessed for age, sex, nature and location of the foreign body, bronchoscopy findings, complications, and airway involvement. A total of 889 children underwent urgent bronchoscopy over 67 years. Most cases (66.7%) occurred within the first three years of life, and 10.6% involved children under one year of age. Recently, a marked decrease in positive findings in infants has been observed. Boys represented 62.5% of cases. Organic foreign bodies, predominantly pumpkin seeds, were most common. The right bronchus was the predominant location (51%). In the most recent period, multiple-location foreign bodies became more frequent. Both the annual number of bronchoscopies and the proportion of positive findings have declined. During the COVID-19 pandemic, suspicion of FBA and the number of bronchoscopies significantly decreased.

***Keywords**: Children. Covid19. Foreign body. Emergency bronchoscopies*

The aspiration of a foreign body (FBA) and a possible airway obstruction as a consequence are a big public healthcare problem around the world. FBA is among the first causes of accidental infant deaths and the fourth most common cause of death in preschool children under five years of age (Cheng J. et al., 2019). General knowledge is that proactive prevention and fast determination of the diagnosis of FBA can save lives (Cohen S. et al., 2015). Despite the improvement in medical care and public awareness, there are approximately 3,000 death cases per year caused by aspiration of a foreign body, and most deaths occur before clinical evaluation and treatment (Rose D. &

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Dubensky L., 2021; Cramer N. et al., 2022). Tracheobronchoscopy belongs to aerosol-generating medical procedures and poses a significant risk of transmission of the sars-coV-2 virus to healthcare workers (Tran K. et al., 2012; Patel Z.M. et al., 2020). In COVID-19 conditions, bronchoscopy was stratified in an urgent, non-urgent, and emergent procedures (Wahidi M.M. et al., 2020).

In comparing Bosnia and Herzegovina with European countries, Lorenzoni G. et al., (2018) indicated that there are significant differences in the group of patients with a foreign body in their ear and upper respiratory tract, while there were no differences in the group of patients with foreign bodies in the lower respiratory tract and digestive tube. Considering our experience in treating foreign bodies lodged in respiratory organs, we believe that rigid bronchoscopy is still a method of choice and a gold standard for the extraction of foreign bodies from children's airways, which is consistent with data from the literature (Liu B. et al., 2020; Aggarwal S.K. et al., 2015; Gang W. et al., 2012).

The purpose of this study was to determine the clinical characteristics and results of the bronchoscopy approach for foreign body aspiration in children's airways, referred to the Clinic for Ear, Nose, Throat Disease and Head Neck Surgery, Tuzla University Clinical Center, in the last 67 years.

Methods

In our study, we evaluated results from children who underwent emergency rigid bronchoscopy for FBA in the period between January 1954 and 31. December 2021. In Clinics for ear, nose, throat, and head and neck surgery, Tuzla University Clinical Center, Bosnia and Herzegovina.

Inclusion criteria were age 0-14 years, urgent rigid tracheobronchoscopy, patients with a clear history of aspiration of a foreign body, a clear history followed by coughing or choking or dyspnea, and an indication from the pediatrician due to suspicion of delayed diagnosis of foreign body aspiration. Exclusion criteria were: tracheobronchoscopy for biopsy, congenital malformations, malignancy, and post-irradiation.

For suspected cases of FBA, the approach followed was including clinical evaluation and thoracic radiological examinations, and, if an emergency endoscopy was needed, referral to a surgical procedure. In clinically stable cases, the necessary examinations are performed, such as intravenous hydration, antibiotics when necessary, and pre-anesthetic evaluation. All patients undergo rigid bronchoscopy in FBA cases, under general anesthesia with spontaneous respiration maintained whenever possible, and continuous monitoring of electrocardiogram, blood pressure, oxygen saturation by pulse oximetry, and precordial stethoscope auscultation. Foreign bodies were removed with appropriate forceps for each case, including reintroducing the bronchoscope to remove any remaining fragments, secretion aspiration, and evaluation of tissue reaction, edema, and other lesions. During the post-procedure period, the children were observed in the recovery room or, if necessary, in the intensive care unit.

During the COVID-19 pandemic, all patients underwent the rRT-PCR test in SARS-CoV-2, and if the patient's condition allowed, the test results were waited for 7 hours on average, and after that, the bronchoscopy was performed. According to the algorithm for the bronchoscopy procedure during the COVID-19 pandemics only symptomatic cases indicating a poor clinical condition with a foreign body in the lower airways were treated as emergent cases.

The following information was obtained from the revised protocols: age, sex, diagnosis, location, and type of foreign body, bronchoscopy findings (positive and negative) and bronchoscopy procedure.

Statistical Analysis

Basic descriptive statistics were based on percentages and absolute numbers. Univariable analysis was based on exact tests for Binomial proportions. Trends over time were estimated using a Generalized Linear Model (GLM) with an appropriate link function (Nelder J.A. & Wedderburn R.W.M., 1972). The analyses were performed using the R system (R Core Team, 2019).

Results

Eight hundred and eighty-nine children underwent a bronchoscopy on suspicion of a foreign body in the lower respiratory tract over a period of 67 years (Table 1). Both mortality and the rate of positive findings decreased significantly over time (Table 1).

Table 1.
Mortality Trends for Performed Bronchoscopies. P-Value for Trend in Mortality over Time: 0.0387. P-Value for Trend in Positive Findings (%) over Time: 0.0163

Period	Total (No.)	Per year (No.)	Positive N	Findings %	Mortality and 95% C.I. (%)
1954-1968	56	-	56	-	3.57 (0 – 8.43)
1971-1985	204	14.57	128	62.7	0.7 (0.4 – 1.84)
1987-1998	230	19.01	136	59.1	0.87 (0 – 2.07)
1999-2004	172	28.6	85	49.4	0.00 (-)
2005-2021	227	13.35	56	24.6	0.44 (0 – 1.30)
2020-2021*	3	1.5	3	100	0.00 (-)

**(Covid 19 time)*

The positive findings rate dropped from 61% in the period 1971-1995 to 38% in the subsequent period.

Clinical Characteristics of Patients

The age of the children ranged from eight months to four years. Most cases (66.7%) occurred within the first three years of the evaluation period, and 75% of cases in children younger than four years. In all periods, there were 10.6% of cases of children under one year of age. Recently, there has been a rapid decrease in the number of positive cases in children under the age of one. The gender structure in the last observation period was 62.5% of men and 37.5% of women, and does not represent a significant deviation from the period 1954-2004 observed previously (Table 2).

Table 2.
Age Distribution of Positive Foreign Body Findings in the Lower Respiratory Tract (%) and Trends over Time

	< 1	< 2	< 3	< 4	> 2	10-14 (years)
1954-1968	10.6	80.3	-----	-----	19.6	2.8
1971-1985	10.7	60.2	67.7	87.7	45.1	0.7
1987-1998	12.4	45.6	69.0	77.7	54.4	14.1
1999-2004	17.9	43.6	59.0	61.5	56.4	23.1
2005-2021	1.7	51.8	71.4	73.2	48.2	1.7
p-value	0.902 (<0.001 2005-21 vs. before)	0.051	0.898	0.186	0.084	0.451

Types of Aspirated Foreign Body

In the observed period, in most cases, foreign bodies are organic in nature (Table 3). Pumpkin seeds are present throughout the period, while beans and coffee pieces have not been present in recent times (the last 17 years). Plastic parts were not present during the period until 2004, after which they were present in a significant percentage (Table 3). Plastic parts are limited to parts of pens or toys.

Table 3.
Types of Extracted Foreign Bodies (%) and Trends over Time

Type	1954-1968	1971-1986	1987-1998	1999-2004	2005-2021	p-value (trend)
Organic	94.6	95.7	83.8	78.1	83.9	
Non organic	5.4	4.3	8.8	15.6	14.3	0.040
Indefinite nature	---	---	7.4	6.3	1.7	-
Peanut	---	15	18.4	37.5	28.5	0.183
Walnut	---	5.7	9.2	12.5	12.5	0.013
Bean	46	29.2	14.6	9.4	---	0.009
Pumpkin seed	12.5	8.5	6.8	3.1	33.9	0.576 (<0.001 2005-21 vs. before)
Grain of coffee	---	8.5	8.8	6.3	---	0.456
Plastic (part of a pen or toy)	---	---	---	---	8.9	-

Location of the Foreign Body

The predominant location of foreign bodies was the bronchi during the entire period, with 51% of the cases in the right bronchus. In the last observed period, the location of foreign bodies in several places has increased significantly compared to the period before 2004.Table 4).

Table 4.
Location of Extracted Foreign Body (%) and Trend over Time

Period	Larynx	Trachea	Right bronchus	Left Bronchus	More locations
1954-1968	0.0	17.8	50.0	32.1	0.0
1971-1985	0.0	20.7	49.3	29.9	0.0
1987-1998	0.7	11.7	53.7	30.1	3.7
1999-2004	0.0	6.3	59.3	31.3	3.1
2005-2021	3.6	3.6	46.8	36.6	7.5
p-value	0.262	0.035	0.690	0.435	0.053

The location of foreign bodies in the bifurcation of the trachea, the left upper and left lower lobar bronchus, then the right middle and right lower lobar bronchus, was recorded in one case (1.78% each).

Discussion

We analyzed eight hundred and eighty-nine children who underwent urgent bronchoscopy on suspicion of a foreign body in the lower respiratory tract over 67 years. All cases of FBA extraction were performed with rigid bronchoscopy. In the analyzed period, neither tracheotomy nor thoracal surgery was performed in order to extract the foreign body from lower airways. We published a study with a similar protocol earlier, where we had analyzed the period 1954-2004 with emergency rigid bronchoscopies in our institution (Brkic F. & Umihanic S., 2007). In this study, we also presented the results of bronchoscopies during the COVID-19 pandemic, which brought some changes in the procedure with respect to staff protection measures. Interestingly, the pattern of FBA changed significantly over the last few years compared to our previous experience, consistent with what was observed in other centers (Ocagli H. et al., 2021).

It has been generally accepted that children under four years of age are more sensitive to foreign body aspiration

because children of that age are led by oral environment research. In such children, the oral cavity is without molars, and there is a lack of swallowing reflex coordination (Reilly J.S. et al., 1996). Smiling, crying, and playing while eating foster the aspiration of foreign bodies (Oğuzkaya F. et al., 1998). In addition to that, the initial reaction of people around the child holding a foreign body in the mouth is important, in the sense of the possibility to cause fear in the child, which can result in deep inspiration with consequential aspiration of a foreign body in the airways. Nevertheless, FBA was drastically reduced in the last period of time as compared to the previous data.

Our data showed 59% positivity for the findings of the bronchoscopy in all periods. A significant decreasing trend can be observed in the percentage of positive findings over time. Of the total number of bronchoscopies, in the period 1971-1995, there were 61% of bronchoscopies with positive results and 38% in the second one ($p<0.001$), consistent with what was observed in the literature, where the percentage of positive bronchoscopies varies between 10% and 75% (Ciftci A.O. et al., 2003; Skoulakis C.E. et al., 2000; Cutrone C. et al., 2011; Puhakka H. et al., 1987; Mani N. et al., 2009).

The issue of bronchoscopy type in FBA treatment remains controversial. In numerous studies, the preference is given to rigid bronchoscopy (Liu B. et al., 2020; Cutrone C. et al., 2011; Baram A. et al., 2017; Shivakumar A.M. et al., 2003; Salih A.M. et al., 2016) and there are also different views on a type of bronchoscopy in the foreign body treatment of the respiratory tract, where flexible bronchoscopy has been favored (Aggarwal S.K. et al., 2015; Gang W. et al., 2012; Midulla F. et al., 2005; Tang L.F. et al., 2009). The general recommendation is to use a rigid bronchoscopy in the cases when the foreign bodies are near epiglottis or glottis, or when a complete obstruction with a foreign body of a part of an airway is present, which leaves the possibility of using forceps or the foreign bodies had a smooth surface which resists the use of classic clamps, while flexible bronchoscopy is recommended in cases with smaller foreign bodies that are placed in segment and subsegment bronchia.

Due to our experience in FBA treatment, we believe that rigid bronchoscopy is still a method of choice and that it represents a gold standard for foreign body extraction from children's airways, and the decision on the choice of procedure type should be left to the physician who has a patient with a foreign body in the airways, depending on the patient's condition, experience, and availability of the instrument for rigid or flexible procedure.
In the retrospective period that was included in the last 17 years, the smallest number of bronchoscopies performed per year (13.3), with the smallest number of positive results (24.6%), compared to the whole observed period of 67 years.

The gender structure in the last period of cases of foreign body impairment was 62.5% of men and 37.5% of women, and does not represent a significant deviation from the previously observed period 1954-2004. The predominance of males compared to females is consistent with most published studies, with a present difference of two or three to one in favor of males (Ramírez-Figueroa J.L. et al., 2005; Mohammad M. et al., 2017; Siddiqui M.A. et al., 2000; Mantel K. & Butenandt I., 1986; French M.A. et al., 2019). The predisposition to the aspiration of foreign bodies by men compared to women can be the result of increased physical activity in the pre-school development period. In the analysis of foreign body injuries compared to Turkey and Europe, Aydın E. et al., (2021) outline that the frequency of injuries is higher in women than in men.

The age of the children ranged from eight months to four years in our study. In all periods, 10.6% of the cases were represented by children under the age of one. In the period 2004-2021 there were 1.7% positive bronchoscopies in patients aging under one. This is in agreement with what Cameron stated (Sheehan C.C. et al., 2018). Indeed, data in the literature on foreign bodies in airways under the age of one present figures between 16% and 73% (Pan H. et al., 2012). In the study by Na'ara S. et al., (2020), 16% of all subjects were younger than one, and in the group of subjects under three years of age, the subjects under one participated with 24%. The authors say that the possible reasons for the large number of children under one are the cultural habit of the population in the region to, at social gatherings where seeds and small food are

consumed, stimulate small children to try new food. Self-feeding is an important risk factor for FBA in children <1 year of age (Özyüksel G. et al., 2019). The authors claim that it is particularly important to pay attention to the beginning of self-feeding, and, in the retrospective analysis, they discovered that 80% of cases aspirated the foreign body during self-feeding.

In Liu B. et al. (2020), FBA was observed in 71.4% of under-three-year-olds. In our study, the percentage of positive bronchoscopies in subjects under three years of age is 71.4%, which represents the largest in the observed age group in the 68 years of analysis. The figures listed and the decrease in the number of bronchoscopies performed in total in the 17 years can be explained by the increase in the level of education on the prevention of foreign bodies in children's airways and better experience in making decisions when establishing the diagnosis of doubt on FBA and performing bronchoscopy.

During the last 67 years, there has been a decrease in mortality at our department, from 3.57% to 0.44% and 0%. These data could be explained with improved equipment quality, improved conditions for procedure execution, and improved skills and knowledge of otorhinolaryngologists and anesthesiologists.

Types of Aspirated Foreign Body

In the observed period, in most cases, FBs are organic in nature, mostly food products such as pumpkin seeds, peanuts, and walnuts. Pumpkin seeds are present throughout the period, while beans and coffee pieces have not been present in the last 17 years. Plastic parts were not present in the period until 2004, after which they are present in a significant percentage. These FBs are parts of a pen or toy. The type of foreign body is closely related to eating habits and in some areas of the world with religious beliefs. In southern China, very common FBAs in infants are animal bones, fish, chicken or pork bone, and pepper (Zhijun C. et al., 2008). Organic FBs are more common at the age of three, and nonorganic, such as a part of a pen, can be found in older children. This was also confirmed in our study.

Location of a Foreign Body

The predominant location of foreign bodies was the bronchi during the whole period, with 51% of cases in the right bronchus. In the period 2005–2021, the location of foreign bodies in several places has increased significantly compared to the period before 2004. The location of foreign bodies at the bifurcation of the trachea, the upper and lower left lobar bronchus, and then the right middle and lower right lobar bronchus was recorded in one case (1.78% each).

Due to the well-known anatomical and physiological characteristics, most foreign bodies are engaged in the right bronchial tree. In the analyzed literature, FBs are found in the right main bronchus 30%–60% and 25%–60% in the left main bronchus, 0%–5% in both bronchi, and the trachea 1.5%–34% in cases (Boufersaoui A. et al., 2013; Korlacki W. et al., 2011; Tahir N. et al., 2009; Frauenfelder C. et al., 2020).

Urgent Bronchoscopy in Covid-19 Times

In our study, we analyzed the two years of the COVID-19 pandemic. Tracheobronchoscopy belongs to aerosol-generating medical procedures and poses a significant risk of transmission of the SARS-CoV-2 virus to healthcare workers (Tran K. et al., 2012; Patel Z.M. et al., 2020). The COVID-19 pandemic significantly affected the protocol of the bronchoscopy process regarding the possibility of fast diagnostics of SARS-CoV-2 infection and staff protection during the procedure.

There were several protocols for management during tracheobronchoscopies and laryngoscopies in the pediatric population around the world, representing modification of a standard procedure, and their goal is to decrease intraoperative exposure to aerosols (Francom C.R. et al., 2020). The protocols are about minimizing the presence of the staff and instruments during the procedure, recommending the Personal Protective Equipment (PPE), and to cover the patients, and providing the removal of aerosol during bronchoscopy.

During the COVID-19 pandemic, all patients underwent the rRT-PCR test on SARS-CoV-2, and if the patient's condition allowed, test results were waited for 7 hours on average, and after that, bronchoscopy was performed. The healthcare workers' PPE contained the coat, gloves, cap, protective mask "FFP2", and the visor for eye protection. A particularly aggravating

circumstance was to work under a visor, using the glasses to correct the diopter due to the decreased visibility and fogged glass. In 2020, which was the first year of the COVID-19 pandemic, no bronchoscopies were performed, nor was there a doubt on an FB in the airways. The aforementioned can be explained by the increased presence of parents with their children, to whom they paid more attention during "lockdown". The aggressive campaign to take preventive measures to protect against COVID-19 also contributed to the aforementioned. There were three bronchoscopies in the second year of pandemics (M: F 2:1; average: 15.3 months; range 12-17 months) that were positive, and one of them was an emergent bronchoscopy without checking the status of COVID-19 due to a poor clinical condition of the patient.

Conclusions

The number of urgent bronchoscopies per year and the percentage of positive findings has been reduced recently, and the type of foreign body location does not differ from Europe. During the COVID-19 pandemics, the suspicion on foreign body and the number of bronchoscopies statistically significantly decreased. The gold standard for the diagnosis and management of an aspirated foreign body is rigid bronchoscopy under general anesthesia. To decrease the risks of foreign body aspiration and prevent adverse outcomes, two strategies are necessary. One strategy implies the procedures of parents and custodians' education and changes in the design of the product that can be inhaled. The other strategy presupposes the education of medical experts to improve their knowledge and experience in foreign body airway diagnostics and treatment.

Declaration of interests

The authors declare that they have no conflict of interest.

Ethics Approval

This study was approved by the institutional ethics committee on 14. 04. 2021. No.: 02-09/2-17/21.

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