

From rigid to flexible bronchoscopy: A tertiary center experience in extraction of inhaled foreign bodies in children

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Abstract

Background: Rigid bronchoscopy is the procedure of choice for removal of inhaled foreign bodies, with certain complication rate. **Aim:** to assess whether flexible bronchoscopy is an efficient and safe procedure in extraction of foreign bodies in children, compared to rigid bronchoscopy. Then, to further assess if it is associated with a shorter procedure time, and shorter length of stay in the hospital (LOS). **Methods:** a retrospective study including patients aged 0-18 years, that were hospitalized in Soroka University Medical Center throughout 2009-2019, and underwent flexible or rigid bronchoscopy for the removal of inhaled foreign body. The data were analyzed according to two time periods; 2009-2016 and 2017-2019. **Results:** from 2009-2019, 182 patients (median age of 24 months, 58% males) underwent an interventional bronchoscopy; 40 (22%) by flexible and 142 (78%) by rigid bronchoscopy. 88.73% of rigid and 95% of flexible bronchoscopies were successful in the removal of foreign bodies (p value=0.24). The rate of major complications was higher among rigid bronchoscopy (9.2 % vs. 0%, p =0.047). From 2017 onwards, after implementation of the flexible bronchoscopy for removal of foreign bodies, 64 procedures were performed; 33 (51.6%) flexible and 31 (48.4%) rigid. Procedure length was found to be shorter via flexible bronchoscopy (42 vs 58 minutes, p = 0.016). No significant difference was found in LOS. **Conclusion:** Flexible bronchoscopy is an efficient and safe method for removal of inhaled foreign bodies in children, with shorter procedure time. It may be the primary procedure for removal of inhaled foreign bodies.

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INTRODUCTION:

Foreign body (FB) inhalation in children has variable presentations; from complete air way obstruction to chronic indolent cough, which require high index of suspicion and thorough anamnestic history [1-3]. Appropriate diagnosis and removal are important to prevent long-term complications in those children [4]. The current procedure of choice for removal of foreign body is rigid bronchoscopy, with potentially high rate of complications [5-7]. The complications are; laryngeal edema, severe mucosal damage, lung atelectasis, pneumothorax, hemorrhage. In some cases even tracheal rupture or bronchial rupture, admission to the PICU for mechanical ventilation, cardiorespiratory arrest, post-procedural respiratory failure and death [8-10]. During the last decade, the indications for flexible bronchoscopy in adults and children were expanded [11] and included foreign body removal [12]. Among adults, the overall success of flexible bronchoscopy in 1,185 subjects (18 studies) for removal of foreign body was 89.6% [13]. In children, the need for smaller instruments delayed this expected process. Most of the instruments came from pediatric urology or gastroenterology invasive procedures, thus, made the removal of FB more feasible in the pediatric population. Until now, small studies were published regarding the removal of FB in children by flexible bronchoscopy, with high rate of efficacy and high safety profile [1, 14-19]. Our aim was to compare flexible to rigid bronchoscopy in the removal of FB, regarding efficacy and safety. We further compared the duration of the two procedures and the length of stay (LOS) in the hospital.

METHODS:

This is a retrospective study, following patients who underwent flexible or rigid bronchoscopy for the removal of inhaled FB between 2009 and 2019. This study included pediatric patients, that were hospitalized in the Soroka University Medical Center (SUMC), a tertiary center in south of Israel.

Patients:

Aged 0-18 years that were highly suspected of FB inhalation, either by anamneses or by radiopaque FB observed in chest x- ray, or demonstrated FB by diagnostic flexible bronchoscopy. A definitive removal procedure in the operation room (OR) was preformed, either by rigid or by flexible bronchoscopy.

Bronchoscopies:

FB were extracted using rigid Hopkins bronchoscope (Storz, 2.9 mm 37 cm) or rigid ventilating bronchoscope or flexible bronchoscope (Olympus, external diameter of 3.6 mm, working channel of 1.2 mm) with the insertion of retrieval basket or grasping forceps, depend of the nature and location of the foreign body. All the bronchoscopies were performed in the OR, with a multidisciplinary team that included anesthesiology specialist, ENT specialist and pediatric pulmonologist. Most patients were deeply sedated, and were on oxygen supplement by reservoir mask. The data about the procedures were taken from the OR reports. We excluded the reports, where flexible and rigid bronchoscopy were done in combination, those that the FB was in the gastrointestinal system and those that FB was not found during the procedure.

Statistical studies:

We compared demographic, clinical and procedure related characteristics as well as outcomes between children who underwent rigid and flexible bronchoscopy using appropriate univariate analyses. Specifically, nominal variables were compared using Pearson's chi-square test, continuous variables that matched parametric criteria were compared by using Student's t-test, and ordinal variables and continuous variables that

did not match parametric criteria were compared by using Wilcoxon or Mann-Whitney U tests. Continuous variables are depicted as mean \pm standard deviation (SD) or as median and interquartile range (IQR), according to their distribution. Categorical data are expressed as percentages. Next, we assessed the difference in those parameters between groups for both trial time periods independently (2009-2016, and 2017-2020). Statistical significance was defined as p-value \leq 0.05. Analyses were performed via IBM SPSS software version 24.

RESULTS:

190 patients underwent interventional bronchoscopy for removal of inhaled FB, eight were eliminated; five for combined use of flexible and rigid bronchoscopies during the same procedure and three for ingestion rather than inhalation of FB (figure 1). 182 patients were eligible (median age of 24 months [Inter quartile range (IQR) 16 months – 8 years], 58% males); 40 (22%) by flexible bronchoscopy and 142 (78%) by rigid bronchoscopy. The demographic details and time interval from admission to procedure were similar between the groups (Table 1). Most of the FB were of organic origin (59%), located in the right main bronchus or its distal branches (53%) and were removed by grasping forceps (19%), when using rigid bronchoscopy or by retrieval basket (45%), when using flexible bronchoscopy (Tables 2a & 2b). Regarding efficacy; 88.73% of rigid bronchoscopies and 95% of flexible bronchoscopies were successful in the removal of FB (p value=0.24). 38 out of 40 (95%) flexible bronchoscopies were successful in removing the FB, while two had failed. In both cases, the FB was metal pin, which was located in the left main bronchus. Both were successfully removed by rigid bronchoscopy during the same procedure. 126 out of 142 (90%) rigid bronchoscopies were successful in removing the FB, while 16 had failed. Out of those that failed; 4 were successfully removed by flexible bronchoscopy during the same procedure, 4 were successfully removed by flexible bronchoscopy in a delayed procedure and 4 were successfully removed by rigid bronchoscopy in a delayed procedure, (usually 2-4 days later, after initiation of systemic steroid and antibiotic treatment), while 2 of them required intubation and pediatric intensive care unit (PICU) admission. 4 additional patients were intubated and admitted to the PICU, stabilized and then, 3 were transferred to a different hospital, where the FB was removed by successful flexible bronchoscopy and one went through thoracotomy in our institution with successful removal of the FB. The complication rate during or post procedure was higher among rigid compared to flexible bronchoscopy; 9.2% vs. 0, respectively (p value=0.047). Most of the complications were disintegrating of the FB (n=7, 6.3%), intubation requiring PICU admission (n=7, 6.3%) and bleeding (n=2). Some patients had more than one complication. Out of the patients that needed intubation; two inhaled organic FB (nut, peanut) that disintegrated, two inhaled metal pin (Hijab) and two had plastic pen cover, that turn out to be one of the most difficult FB to remove, due to its round shape and slippery characteristic. One patient was intubated before the bronchoscopy and not as a consequence of the procedure, because he was unstable. Throughout the first period of the study (2009-2017) 118 procedures were performed; 111 (94%) rigid bronchoscopies and 7 (6%) flexible bronchoscopies. We found no statistical significance in procedure length between flexible and rigid bronchoscopies; 61 min' vs. 48 min', respectively (p value 0.408) (Table 3a). From 2017 onwards, after implementation of the flexible bronchoscopies for extraction of inhaled FB, 64 procedures were performed; 33 (51.6%) flexible bronchoscopies and 31 (48.4%) rigid bronchoscopies. Procedure length was found to be significantly shorter by 16 minutes, via flexible compared to rigid bronchoscopy; 42 min' vs. 58 min', respectively (p value 0.016) (Table 3b). No statistically significant difference was found in LOS after rigid compared to flexible bronchoscopy (39 vs 33 hours, p value 0.649).

DISCUSSION:

Flexible bronchoscopy has become a common practice for the removal of inhaled FB in adults, due to safety profile and high successful rate of the procedure. The limitations of equipment's size in the pediatric population made this procedure less abundant. Lately, more studies were published, regarding children, with high successful rate, and high safety profile. As far as we know, this is the first study aimed to compare those two procedures, flexible versus rigid bronchoscopies, performed during the same period, under the same conditions. Our results strengthen the conclusion that flexible bronchoscopies are highly efficient and safe procedure in the removal of FB among children. In the cases that flexible bronchoscopy was not successful,

the FB (metal pin) were removed by rigid bronchoscopy during the same procedure. Therefore, in a case of inhaled metal pin or other slippery objects (piece of glass, plastic pen cover), we recommend a combination of the two procedures in the operation room, with immediate backup of rigid bronchoscopy. Our results demonstrate the trend towards using flexible bronchoscopy as the primary method in pediatric population, as presented by the elevated rate during 2017 and so on (figure 2). Our results also support the notion that removal of FB by a flexible bronchoscopy is an upcoming technique, and like every new technique, has a learning curve. High successful rate, low complication rate and shorter length of procedure emphasize the experience of performer achieved over time. Regarding LOS, although the procedure was significantly shorter by flexible bronchoscope, there was no difference in LOS, probably reflecting the fact that length of hospitalization is determined by different medical and non-medical parameters.

Our main limitation is the retrospective nature of our study, with missing reported data in the patients' files. For example the assisted tool that was used for removal was not documented in the majority of the files (77% and 35% of the rigid and flexible bronchoscopy, respectively).

Another important point is the procedure length; in our institution, while performing bronchoscopy in the operation room, the time is recorded from the minute the patient is entering the OR until the end of anesthesia. Of course, this time frame is much longer than the actual procedure itself. Since the study had compared the two procedures in similar conditions, this bias is applicable for both groups.

We recommend that flexible bronchoscopy will become the primary procedure for removal of FB in children, by experienced multidisciplinary team, in setting of the OR, with the backup of rigid bronchoscopy and ENT specialists.

CONCLUSION:

Flexible bronchoscopy is an efficient and safe method for removal of inhaled foreign bodies in children. Flexible bronchoscopy is associated with shorter procedure length, but with similar LOS. Flexible bronchoscopy should be considered as the primary procedure for removal of inhaled foreign bodies, by a multidisciplinary trained team.

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Legend to Figures:

Table 1: Population characteristics, procedural characteristics and clinical outcomes

Table 2a: Procedure characteristics and complications; 2009-2016.

Table 2b: Procedure characteristics and complications; 2017-2019.

Table 3a: Procedural and clinical outcomes; 2009-2016.

Table 3b: Procedural and clinical outcomes; 2017-2019.

Figure 1: Flow chart of study population

Figure 2: Trends in flexible and rigid bronchoscopies during 10 years period

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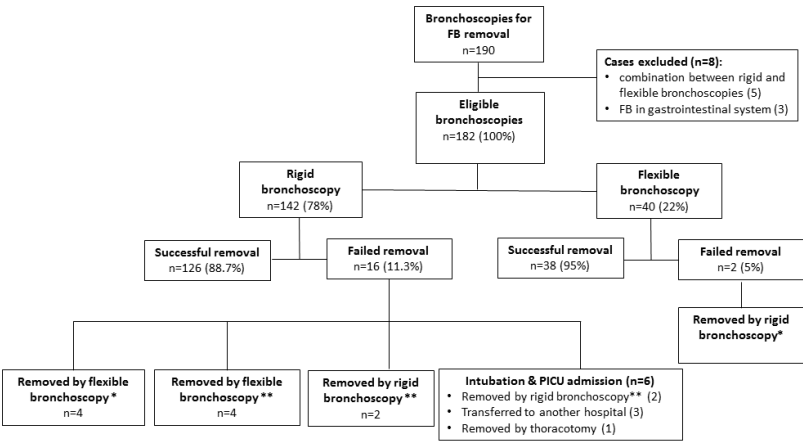


Figure 1: flowchart of study population; * during the same procedure ** during a different procedure. FB=foreign body, PICU=pediatric intensive care unit.

