Research Article / Araştırma Makalesi

Foreign Body Aspiration in Children: Review of 198 Cases from Anesthesiology Perspective

Çocuklarda Yabancı Cisim Aspirasyonu: Anesteziyoloji Perspektifinden 198 Olgunın İncelenmesi

Mehmet Kenan EROL [1], Tansel GÜNENDİ [2], Firdevs KAYA [1], Mustafa Erman DÖRTERLER [2]

[1]Department of Anesthesiology and Reanimation, School of Medicine, Harran University, Şanlıurfa, TÜRKİYE
[2]Department of Pediatric Surgery, School of Medicine, Harran University, Şanlıurfa, TÜRKİYE

Abstract

Background: Tracheobronchial foreign body aspiration is an emergency in childhood. Rigid bronchoscopy is used for diagnosis and treatment. In our retrospective study, we aimed to evaluate anesthesia management, age, gender, intraoperative blood pressure, pulse, saturation, intraoperative and postoperative complications, foreign body type and localization and length of hospitalization.
Materials and Methods: The file of 198 pediatric patients who underwent rigid bronchoscopy by pediatric surgery with the diagnosis of foreign body aspiration in Harran University Medical Faculty Hospital between 2016-2018 were retrospectively analyzed. All cases were managed under general anesthesia. The anesthesia management, age, gender, intraoperative blood pressure, pulse, saturation, intraoperative and postoperative complications, foreign body and localization, length of stay were obtained from patient records and retrospectively evaluated.
Results: Localization of foreign bodies were found to be 4.5% in trachea, 48% in right main bronchus and 33.9% in the left main bronchus. 25.3% of foreign bodies were seed, 25.62% were peanuts and 5.62% were organic substances such as beans, needle was removed in 7.6% cases, and toy pieces was removed in 9.6% cases respectively. Low levels of saturation, hypercarbia, arrhythmia, laryngospasm and bronchospasm were observed as complications of anesthesia.
Conclusions: Foreign body aspiration is an emergency that requires early diagnosis and urgent intervention. It is important to be aware of the complications that may occur during anesthesia and momentous to be intervened by an experienced team.

Key Words: Bronchoscopy; anesthesia, foreign body, pediatrics

Öz

Amaç: Trakeobronşiyal yabancı cisim aspirasyonu çocukluk çağında acil bir durumdur. Tanı ve tedavi için rijit bronkoskopi kullanılır. Retrospektif çalışmamızda anestezi yönetimi, yaş, cinsiyet, intraoperatif kan basıncı, nabız, satürasyon, intraoperatif ve postoperatif komplikasyonlar, yabancı cisim tipi ve lokalizasyonu ve hastanede yatış süresini değerlendirmeyi amaçladık.
Materyal ve Metod: 2016-2018 yılları arasında Harran Üniversitesi Tıp Fakültesi Hastanesi'nde yabancı cisim aspirasyonu tanısı ile çocuk cerrahisi ile rijit bronkoskopi yapılan 198 çocuk hastanın dosyası retrospektif olarak incelendi. Tüm olgular genel anestezi altındamuayene edildi. Hasta kayıtlarından anestezi yönetimi, yaş, cinsiyet, intraoperatif kan basıncı, nabız, satürasyon, intraoperatif ve postoperatif komplikasyonlar, yabancı cisim ve lokalizasyon, hastanede kalış süreleri kaydedildi ve retrospektif olarak değerlendirildi.
Bulgular: Yabancı cisim yerleşimi trakeada %4,5, sağ ana bronşta %48 ve sol ana bronşta %33,9 olarak bulundu. Yabancı cisimlerin %25.3'ü tohum, %25.62'si yer fıstığı ve %5.62'si fasulye gibi organik maddeler, %7.6'sı iğne, %9.6'sı oyuncak parçaları çıkarıldı. Anestezi komplikasyonları olarak düşük satürasyon, hiperkarbi, aritmi, laringospazm ve bronkospazm gözlendi.
Sonuç: Yabancı cisim aspirasyonu erken tanı ve acil müdahale gerektiren acil bir durumdur. Anestezi sırasında oluşabilecek komplikasyonların farkında olunması ve deneyimli bir ekip tarafından müdahale edilmesi önemlidir.

Anahtar Kelimeler: Bronkoskopi, anestezi, yabancı cisim, pediatri

Corresponding Author / Sorumlu Yazar

Dr. Mehmet Kenan EROL
Harran Üniversitesi, Tıp Fakültesi, Anesteziyoloji Ve Reanimasyon Anabilim Dalı Şanlıurfa/ TÜRKİYE

E-mail: kenanerol970@gmail.com

Received / Geliş tarihi: 17.10.2022

Accepted / Kabul tarihi: 09.11.2022

DOI: 10.35440/hutfd.1190298

Introduction

Tracheobronchial foreign body aspiration (FBA) is an important emergency that can lead to death in childhood. Bronchoscopy provides rapid diagnosis and treatment which may prevent mortality and subsequent complications. FBA patients undergoing bronchoscopy are in high-risk group because these patients are always urgent cases with serious complication rates and the procedure involves serious difficulties (1).

Bronchoscopy is an invasive procedure that allows inspection of the trachea and bronchi as well as performing surgical procedures like foreign body removal or punch biopsies. Rigid bronchoscopy (RB) is widely used for this purpose. The advantages of RB is to provide safe airway and sustain ventilation during the procedure, and to enable the use of optical system along with foreign body forceps from the same channel (2,3). The most common indications of RB include endoscopic treatment of central airway obstruction, removal of foreign body, diagnosis and treatment of massive hemoptysis. In children, foreign bodies in the airway is the most frequent indication (4). Because of the simultaneous use of the airway with surgical team, ventilation and oxygenation is disrupted during intervention and hemodynamic disturbances during the procedure generally decrease PaO2, increase PaCO2 and airway resistance that cause respiratory distress in most patients. The procedure's urgent nature along with inadequate fasting period increases the complication rate and the difficulty of the procedure (5,6).

In this study, we aimed to evaluate children who were managed with rigid bronchoscopy with our pediatric surgery clinic between 2016-2018 for age, sex, intraoperative blood pressure, pulse, saturation, intraoperative and postoperative complications, foreign body types and localization and duration of hospitalization.

Materials and Methods

After the approval of the Ethics Committee of Harran University Faculty of Medicine (08.04.2019 and 04/20), the files of 198 pediatric patients who underwent RB by pediatric surgery with the diagnosis of foreign body aspiration between 2016-2018 in Harran University Medical Faculty were retrospectively analyzed.

The anesthesia management, age, sex, intraoperative blood pressure, pulse, saturation, intraoperative and postoperative complications, foreign body and localization, length of stay were recorded and evaluated. All patients were managed under general anesthesia. Ventilation management were recorded in anesthesia operation forms. The drugs used in anesthesia induction and maintenance (intravenous, inhalation agents, neuromuscular blocker), intraoperative complications, postoperative intubation and other drugs (reversal agents, steroid) were evaluated. ECG, SpO2, ETCO2 monitoring was performed in all patients.

After induction was achieved with sevoflurane and neuromuscular agent in children under 2 years of age and with propofol and neuromuscular agent in children over 2 years of age, anesthesia maintenance was achieved with 2-3% sevoflurane and oxygen-air mixture. It is aimed that oxygen saturation (SpO2) does not fall below 90% during ventilation and the end-tidal carbon dioxide (ET-CO2) is maintained between 35-45mmHg, and if it falls so, the oxygen concentration is increased to raise it over 90%. 1 mg/kg methylprednisolone was administered to all patients during the procedure. The anesthesia circuit for ventilation was connected to RB by airway extension and manually controlled ventilation was implemented. After the procedure was completed, all patients were intubated and ventilated, and patients with stable vital signs with good SpO2, ET-CO2 values were extubated and sent to recovery room. Patients who were full conscious were sent to the service ward. Patients who were not sufficiently breathing or hemodynamically unstable after RB were referred to the intensive care unit(ICU) and follow-up treatments were performed in the ICU.

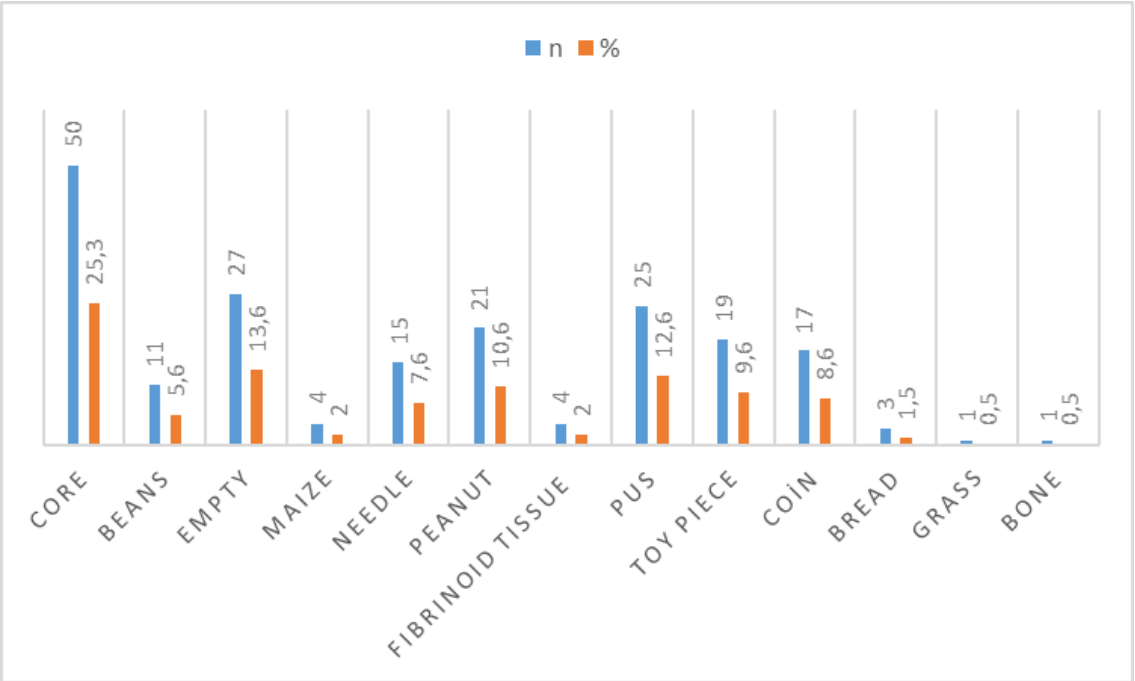
Data were analyzed using ''SPSS for Windows 23.0'' software program for statistical evaluation and chi-square test was used to compare the differences between groups. $p < 0.05$ was considered significant.

Results

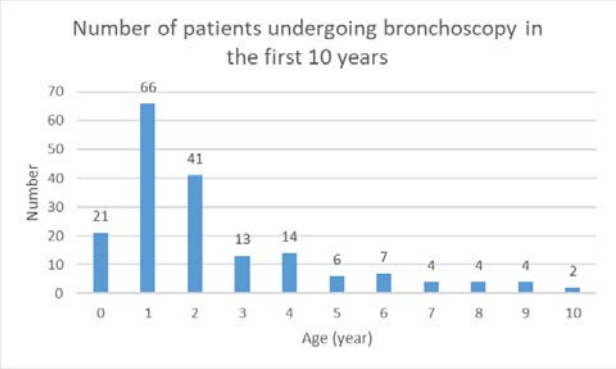
The mean age of the patients was 3.24±3.7 months (1 months-16 years) with a slight male preponderance of 57.4% male and 42.4% female and male / female ratio was (114/84) (Graphic-2). Localization of foreign bodies were trachea (4.5%) in 9 patients, right main bronchus in 48 patients (48%) and left main bronchus in 67 patients (33.9%) (Graphic-3). In 27 patients (13.6%) no foreign bodies were found in bronchoscopy. Foreign bodies in bronchoscopy were visualized as sunflower seeds in 25.3% of patients (n = 50), peanuts in 10.62% (n = 21), beans in 5.62% (n = 11), metal needle in 7.6% (n = 15), toy parts in 9.6% (n = 19) and pus in 12.6% patients (n = 25) respectively. Chicken bone was removed in 1 case (%0,005) (Graphic-1). Out of our 198 patient group, 19 patients (9.6%) were consultated from other medical centers to pediatric surgery with symptoms of recurrent or treatment-resistant lung infections and 179 patients (90.4%) presented directly to pediatric surgery with acute respiratory symptoms which were acute shortness of breath in 88 patients as the most common finding (44.4%), dyspnea in 56 patients (28.3%), and cyanosis in 35 patients (17.7%) (Table 1).

In radiologic work-up, a chest X-ray was the first choice as imaging modality and for recurrent or theraphy-resistant lung infections a chest CT was also obtained in selected patients.

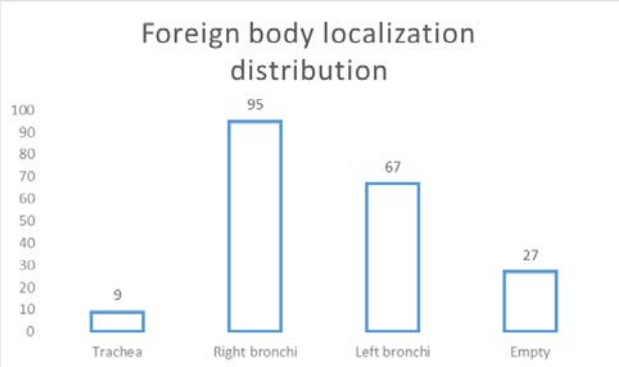
Air trapping was the most frequent radiological finding in 128 patients (64.7%), normal lung image in chest X-ray in 45 patients (22.7%), and foreign body image in 25 cases (12.6%).



Graphic 1. Foreign bodies removed by bronchoscopy are indicated by the number of patients and percentage



Graphic 2. Number of patients undergoing bronchoscopy in the first 10 years



Graphic 3. Foreign body localization distribution

Throughout the operation, the most common complications encountered during per-operative anesthesia management was saturation decrease (SpO2 <95%) in 96 cases (48.5%), arrhythmia (bradycardia, tachycardia, ventricular extrasystoles) in 24 patients (12.1%), hypercarbia in 50 patients (25.3%), and bronchospasm in 28 patients (% 14.1). After extubation, laryngeal edema occurred in 97 cases (49%), low saturation rates in 65 cases (32.8%), laryngospasm in 11 cases (5.6%), ongoing cough in 21 cases (10.6%). and bronchospasm in 4 patients (2%) respectively. Following bronchoscopy, 151 patients (76.3%) were discharged the following day, 29 patients (14.6%) were discharged on the 2nd post-operative day and 8 patients (4%) were discharged on the 3rd post-operative day. 10 patients (5%) were discharged between 4 to 14 days. 18 patients (9.1%) were followed-up in the intensive care unit due to ongoing desaturation and respiratory distress.

All bronchoscopies were performed under general anesthesia. Rocuronium was used as the neuromuscular agent. After anesthesic induction was achieved with sevoflurane and rocuronium combination under 2 years of age and with propofol and rocuronium combination over 2 years of age, maintenance was carried out by sevoflurane %2-3, oxygen-air mixture. When it was decided by the anesthesia team that the depth of anesthesia and muscle relaxation were sufficient, a bronchoscope was inserted into the trachea after oxygen and anesthesia circuit were connected to the side arm of the bronchoscope. 1 mg / kg methylprednisolone was administered in all patients per-operatively. The operation time of the patients who were referred to the intensive care unit was 32.1 ± 2.96 minutes, while the operation time of the patients who were not referred to the intensive care unit was 6.26 ± 2.89 minutes. This difference was statistically significant ($p < 0.05$). After the procedure was completed, all patients were intubated, ventilated, and once the SpO2, ET-CO2 values and vital signs were stabilised, patients were extubated and sent to recovery room.

After all of the discharge criteria are met, the patient was discharged by their anesthesiologist to the inpatient room. Patients who were stable after their follow-up and treatment were discharged. Patients who were unstable respiratory or hemodynamically were referred to intensive care unit.

Table 1. Distribution of symptoms

Symptom	n	%
Cough	88	44.4
Shortness of breath	56	28.3
Cyanosis	35	17.7
Asymptomatic	19	9.6

Table 2. Ph, pO2, pCO2 values of patients sent to intensive care unit

	n	Min.	Max.	Mean	SD
pH	18	7.20	7.40	7.3050	.5512
pO2	18	63.00	88.00	77.9444	8,57131
PCO2	18	45.00	54.00	49.5000	2.57248
Valid n (listwise)	18				

Min: Minimum, Max: Maximum, SD: Standart Deviation

Discussion

Foreign body aspiration is a common clinical condition in childhood. Especially foreign body aspiration is one of the most important causes of death in the 1-3 years of age group. The anatomical features of this age group are at risk due to incomplete airway reflexes. Reasons for admission can be observed in a wide range from nonspecific findings, normal physical examination, suspected aspiration history, and radiological findings to severe respiratory distress and respiratory arrest (7). RB is most commonly used in children due to foreign body aspiration (2). Although fiberoptic bronchoscope is used in some centers, RB is still respected as the gold standard in foreign body aspiration and our pediatric surgery clinic is preferring this method. For this reason, RB is safely used as a diagnostic and treatment method in foreign body aspirations within the reach of RB, especially in the presence of an experienced team (8).

In the retrospective analysis of our cases, propofol and sevoflurane were detected to be used as anesthesia induction agents. These options are consistent with the literature (9). Sevoflurane was preferred in children only under 2 years of age who did not have an intravenous (iv) route because it has less irritant effect on airways than other inhalation agents (8). It is important to note that ventilation and intravenous intervention are provided by the experienced team quickly and safely (2). Controlled ventilation using rocuronium administration was performed in all of our cases. The use of neuromuscular blockers is especially recommended in patients with controlled ventilation, and it is frequently stated that depolarizing or short-acting non-depolarizing neuromuscular blockers should be used (9). In addition, airway reflexes are suppressed by the use of neuromuscular blockers offering a comfortable working area to the surgeon (8). To antagonize the effects of neuromuscular blockers during emergence phase, neostigmine and atropine were used in patients under 2 years of age and sugammadex was used in patients over 2 years of age.

The use of spontaneous or controlled ventilation in RB is a controversial issue (10,11). In some studies, it is stated that spontaneous ventilation can be applied especially during the removal of foreign bodies (12,13). However, Divisi et al. stated that spontaneous ventilation may result in inadequate oxygenation and is not suitable for this procedure (14). Similarly, Chen et al. reported that spontaneous ventilation increased intraoperative hypoxemia in their studies in which they evaluated controlled ventilation versus spontaneous ventilation during foreign body removal (12). We performed controlled ventilation in all cases.

The mean age of our cases was 3.24 and it was reported in the literature between the ages of 0-4. While the incidence of foreign body aspiration was 65-75% in the first 3 years of age in the literature, it was 71.1% in our study. Male / female ratio was 1.36 in our patient population, this ratio was reported 1.54 in the literature. In general, foreign bodies detected during bronchoscopy are organic substances. Nuts like peanuts or sunflower seeds and legumes like beans or millet are encountered more commonly (8). In our study, organic substances were removed in 46% of the patients (n = 91) and it is consistent with the current literature (15). Although there are different statistics on the localization of the aspirated body in the scientific data, the incidence of right main bronchus is higher. This may be caused by the narrower angle of the right main bronchus with the trachea causing a higher rate of ventilation to the right main bronchus (8,9). Yang et al reported that right and left bronchial localization in children is branched at equal angles and therefore foreign bodies can be seen equally in both bronchi (15). Korlacki et al detected foreign bodies mostly in the left bronchus (11). In our study, foreign body was detected in the right main bronchus in 98 patients while it was 63 patients which the foreign body was detected in the left main bronchus. This finding is consistent with the literature but no statistical difference was found.

Negative bronchoscopy is a common issue in bronchoscopic procedures since none of the clinical findings or imaging methods are truly pathognomonic. Values ranging from 15% to 42% have been reported in the literature (8). In our study, the rate of negative bronchoscopy was found to be 26.2%.

Yang et al. reported the most common symptoms as dyspnea, cough and wheezing (15). The most common findings in our study were dyspnea and cough as well. In addition, asphyxia-induced cyanosis was observed in 35 patients (17.7%).

Complications in RB occur due to the bronchoscope's rigid nature, the drugs used throughout the procedure, and the ventilation techniques performed by anesthesiologist. Damage to the oral and dental structures, hypoxia, hypercar-

bia, cough, bronchospasm, laryngeal edema, pneumothorax, pneumo-mediastinum, fever and infection are the chief complications (1,3,7). All our patients received steroids intraoperatively. With this mode of therapy, it is aimed to prevent possible broncholaryngospasm by reducing edema caused by rigid bronchoscope manoeuvres or by foreign body itself lodged in the trachea and main bronchi. Although clinicians do not have a common decision on the use of steroids, some publications have emphasized the importance of routine use of them (2,8). The most common complications encountered after foreign body removal include pneumonia, atelectasis and emphysema. Urfalıoğlu et al. reported desaturation, arrhythmia, bronchial spasm and laryngeal spasm during foreign body removal. They pointed out to foreign body manipulation, interruption of ventilation and superficial anesthesia as the leading causes of these complications (16). We believe that controlled ventilation using muscle relaxants and coordinated work with the surgical team have a positive effect on this condition. Because of the common use of the airway with the surgical team during bronchoscopy, intermittant hypoventilation in the course of foreign body removal and rigid bronchoscope manoeuvres performed in the more distal airways may exacerbate hypoxia and hypercarbia. However, these complications can be alleviated by withdrawing the bronchoscope back to the trachea providing more effective ventilation (1,17, 18,19).

Korlacki et al reported a 5 to 90 minutes interval of operation time in their study (11). Our operation time for patients who were sent to inpatient room was 6.26 ± 2.89 minutes and for patients who were referred to intensive care unit was 32.1 ± 2.96 minutes, respectively. Experince has shown that as the operation time extends, there is a higher chance that the patient will be sent to intensive care unit postoperatively and we wanted to underline this period of time with our own numbers. According to Zur et al, once the surgical procedure is accomplished, emergence of the child is performed with or without the presence of an endotracheal tube, which depends on the personal preference of the anesthesiologist (20). With this insight we aim to point out to a certain period of time whether the patient should be emerged intubated or if the operation time is extended, extubated In our small series, we found that bronchoscopies that extend 30 minutes were emerged intubated and sent to intensive care unit.

Conclusion

Tracheobronchial foreign bodies are most frequently observed in younger children with serious life-threatening effects. Bronchoscopy following rapid diagnosis can prevent life long suffering complications such as prolonged anoxia, chronic airway diseases and even mortality. Patients undergoing bronchoscopy are at a high risk group because of the urgent nature of this entity with its serious complication rate and the procedure involves serious difficulties for both the pediatric surgery and the anesthesiology team. Foreign bodies that lodge in the distal airways, especially organic ones that swell and disintegrate into even smaller pieces while removal often prolong bronchoscopy. In such cases, extubation of the patient is harder and Intensive Care Unit follow-up is paramount. We believe that this decision should be given by blood gas analyses before extubation and duration of the procedure. If the operation lasts longer than 32,1±2,96 minutes, pH value is lower than 7,30 and pCO_2 is higher than 50 mmHg, the patient should be sent to the intensive care unit intubated. Owing to the nature of our small group of patients, these values need to be verified by future studies that contain larger number of patients.

Ethical Approval: Ethics Committee of Harran University Faculty of Medicine (08.04.2019 and 04/20)

Author Contributions:
Concept: M.K.E
Literature Review: M.K.E , F.K
Design : M.K.E , T.G
Data acquisition: M.K.E , F.K, M.E.D
Analysis and interpretation: M.K.E , T.G
Writing manuscript: M.K.E, T.G, M.E.D
Critical revision of manuscript: M.K.E , F.K ,T.G,M.E.D

Conflict of Interest: *The authors have no conflicts of interest to declare.*
Financial Disclosure: *Authors declared no financial support.*

References

1. Tomaske M, Gerber AC, Weiss M. Anesthesia and periinterventional morbidity of rigid bronchoscopy for tracheobronchial foreign body diagnosis and removal. Paediatr Anaesth. 2006;16(2):123-9.
2. Öç B, Arun O, Öncel M, Duman A. Trakeobronşial sistemdeki yabancı cisimlerde anestezi uygulaması. Arşiv Kaynak Tarama Dergisi. 2014;23:328-44.
3. Soyer T. The role bronchoscopy in the diagnosis of airway disease in children. J ThoracDis. 2016;(8):3420-6.
4. Perez-Frias J, MorenoGaldo A, PerezRuiz E, BarrioGomez De Aguero MI, Escribano Montaner A et al. Pediatric bronchoscopy guidelines. ArchBronconeumol. 2011;(47):350-60.
5. Farrel P. Rigid broncoscopy for foreign body removal: anesthesiaand ventilation. PedAnesthesia 2004;14:84-9.
6. Swanson KL, Edell ES. Tracheobronchial foreign bodies. ChestSurg Clin N Am. 2001;(11):861-72.
7. Sinha V, Umesh TS, Jha SG. Rigid Bronchoscopy in Pediatric Patients Indian J Otolaryngol-Head Neck Surg. 2017; 69(4):449–452;
8. Kendigelen P.The anaesthetic consideration of tracheobronchial foreign body aspiration in children. J ThoracDis. 2016; 8(12): 3803–3807.
9. Kalyanappagol VT, Kulkarni NH, Bidri LH. Management of tracheobronchial foreign body aspirations in paediatric age group - A 10 year retrospective analysis. Indian J Anaesth. 2007;51:20-3
10. Fidkowski CW, Zheng H, Firth PG. The anesthetic considerations of tracheobronchial tforeign bodies in children: a literature review of 12,979 cases. Anesth Analg. 2010;111:1016-25.

11. Korlacki, Wojciech; Korecka, Klaudia; Dzielicki, Józef. Foreign body aspiration in children: diagnostic and therapeutic role of bronchoscopy. *Pediatric surgery international*, 2011;27(8): 833-837.
12. Chen LH, Zhang X, Li SQ, Liu YQ, Zhang TY, Wu JZ. The risk factors for hypoxemia in children younger than 5 years old undergoing rigid bronchoscopy for foreign body removal. Anesth Analg. 2009;109:1079-84.
13. Cai Y, Li W, Chen K. Efficacy and safety of spontaneous ventilation technique using dexmedetomidine for rigid bronchoscopic airway foreign body removal in children. Paediatr Anaesth. 2013;23:1048-53.
14. Divisi D, Di Tommaso S, Garramone M, Di Francescantonio W, Crisci RM, Costa AM et al. Foreign bodies aspirated in children: role of bronchoscopy. Thorac Cardiovasc Surg. 2007;55:249-52.
15. Yang, Yi-Hui, et al. Risk factors for preoperative respiratory complications in children with tracheobronchial foreign bodies. *Journal of International Medical Research*, 2016; 44(2): 338-345
16. Urfalıoğlu A, Arslan M, Gişi G, Bilal B, Karakaya AE, Öksüz H. Trakeobronşial sisteme yabancı cisim aspirasyonu olan pediatrik olgularda uygulanan rijitbronkopi işleminde anestezi deneyimlerimizin retrospektif analizi. Maltepe Tıp Dergisi. 2015;7:1-7.
17. Erginel, Başak, et al. Rigid Bronchoscopy In The Treatment Of Foreign Body Aspiration. *Journal of Istanbul Faculty of Medicine*, 2016; 79(3): 113-116.
18. Farrell PT. Rigid bronchoscopy for foreign body removal: anaesthesia and ventilation. Paediatr Anaesth. 2004;14:84-9.
19. Zhijun C, Fugao Z, Niankai Z, Jingjing C. The rapeuticexperiencefrom 1428 patients with pediatric tracheobronchial foreign body. J Pediatr Sur 2008;43:718-21.
20. Zur KB1, Litman RS. Pediatric airway foreign body retrieval: surgical and anesthetic perspectives. Paediatr Anaesth. 2009;19(1):109-17.