GKDA Derg 2020;26(4):221-7
doi: 10.5222/GKDAD.2020.27147

Araştırma / *Research Article*

# Clinical Effects of Different Rocuronium Doses Used in Pediatric Rigid Bronchoscopy

**Sema Şanal Baş**
**Yeliz Kılıç**

# *Pediyatrik Rijit Bronkoskopide Uygulanan Farklı Rokuronyum Dozlarının Klinik Etkileri*

**Etik Kurul Onayı:** Eskişehir Osmangazi Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu'ndan onay alınmıştır (13.06.2016/181).
**Çıkar Çatışması:** Çıkar çatışması yoktur.
**Finansal Destek:** Bu çalışma, herhangi bir fon tarafından desteklenmemiştir.
**Hasta Onamı:** Her hastadan yazılı olarak bilgilendirilmiş onam alındı.

**Ethics Committee Approval:** Approval was obtained from Eskişehir Osmangazi University Non-Invasive Clinical Research Ethics Committee (13.06.2016 / 181).
**Conflict of Interest:** There is no conflict of interest.
**Funding:** This study was not supported by any funding.
**Informed Consent:** Written informed consent was obtained from each patient.

**Cite as:** Şanal Baş S, Kılıç Y. Clinical effects of different rocuronium doses used in pediatric rigid bronchoscopy. GKDA Derg. 2020;26(4):221-7.

## ABSTRACT

***Objective:*** *The bronchoscopy employed for the diagnostic and therapeutic purposes in the children admitting as a result of foreign body aspiration is performed with general anesthesia. In our study, we aimed to compare clinical efficacy and perioperative adverse adverse effects (broncoscophy, body movement, laryngospasm, bronchospasm, hypoxemia) by using rocuronium in varying doses in our pediatric patients who underwent rigid bronchoscopy.*
***Method:*** *Pediatric patients who were subjected to rigid bronchoscopy were included in a retrospective study. The patients receiving 0.3 mg/kg (ED95) of rocuronium were included in Group I, 0.45 mg/kg (1.5 x ED95) in Group II and 0.6 mg/kg (2 x ED95) in Group III. The patients were evaluated in terms of duration of anesthesia, duration of bronchoscopy, body movement, additional drugs and development of complications.*
***Results:*** *Total 60 patients, 19 female and 41 male, with age in the range of 6 months-6 years were included in the study. The duration of anesthesia was longer in Group III than the other two groups. When the groups were compared with regard to body movement, bronchospasm, laryngospasm and hypoxemia during the bronchoscopy, the adverse events in Group I were found to be significantly different. Anesthesia duration and adverse effects were significantly less in Group II.*
***Conclusion:*** *In our study is used to different rocuronium doses for pediatric rigid bronchoscopy. We consider that the dose of 0.45 mg/kg rocuronium resulted in rapid relaxation and safe ventilation in the pediatric rigid bronchoscopy patients.*

***Keywords:*** *rigid bronchoscopy, pediatric, rocuronium bromide*

## ÖZ

***Amaç:*** *Yabancı cisim aspirasyonu ile başvuran çocuklarda tanı ve tedavi için uygulanan bronkoskopi genel anestezi altında yapılmaktadır. Çalışmamızda rijit bronkoskopi yapılan pediyatrik hastalarımızda değişen dozlarda roküronyum kullanarak klinik etkinliği ve perioperatif istenmeyen etkileri (bronkoskopi, vücut hareketi, laringospazm, bronkospazm, hipoksemi) karşılaştırmayı amaçladık*
***Yöntem:*** *Yabancı cisim aspirasyon nedeni ile başvuran ve rijid bronkoskopi yapılan çocuk hastalar çalışmaya dâhil edildi. Altmış çocuk hastanın 19 kız, 41 erkek yaşları 6 ay-6 yaş arasında retrospektif olarak çalışmaya alındı. Rokuronyum 0.3 mg/kg (ED 95) alan hastalar Grup I, rokuronyum 0.45 mg/kg (1.5xED95) Grup II, rokuronyum 0.6 mg/kg (2xED95) alanlarda Grup III olarak gruplandırıldı. Hastalar anestezi süresi, bronkoskopi süresi, vücut hareketliliği, ek ilaçlar ve komplikasyon gelişimi açısından değerlendirildi.*
***Bulgular:*** *Anestezi süresi Grup III'de diğer gruplara göre daha uzundu. Bronkoskopi uygulamasında vücut hareketliliği, bronkospazm, laringospazm ve hipoksemi açısından gruplar karşılaştırıldığında Grup I'de yan etkiler anlamlı olarak farklı bulundu. Grup II'de anestezi süresi ve advers etkiler anlamlı olarak az bulundu.*
***Sonuç:*** *Çalışmamızda pediyatrik rijit bronkoskopi için farklı rokuronyum dozları kullanılmıştır. Pediyatrik rijit bronkoskopi hastalarında roküronyum dozunun 0,45 mg/kg ile hızlı kas gevşemesi ve güvenli ventilasyonla yapılabileceğini düşünmekteyiz.*

***Anahtar kelimeler:*** *rijit bronkoskopi, pediyatri, rokuronyum bromid*

**Received/Geliş:** 05.12.2020
**Accepted/Kabul:** 10.12.2020
**Published Online/Online yayın:** 31.12.2020

**Sema Şanal Baş**
Meşelik Kampüsü ESOGÜ
Tıp Fakültesi Hastanesi
Anesteziyoloji Sekreterliği
26480 Eskişehir - Türkiye
drsemasa@gmail.com
**ORCİD:** 0000-0002-2943-0456

**Y. Kılıç** 0000-0003-1446-7747
*Eskişehir Osmangazi Üniversitesi*
*Tıp Fakültesi Hastanesi*
*Anesteziyoloji ve Reanimasyon Anabilim Dalı*
*Eskişehir, Türkiye*

## INTRODUCTION

The pediatric rigid bronchoscopy employed for the diagnosis and treatment of the tracheobronchial foreign body aspiration is usually performed with general anesthesia. Serious difficulties, such as the effects on ventilation and oxygenation, may result from the common use of the airway by the physician performing the bronchoscopy and by the anesthesiologist [1-6].

Different ventilation methods and anesthetic practices are available in literature. These practices usually vary based on the experience of the anesthesiologist and the protocols of the hospital [2,4,7-14]. The debates over the respiratory mode (spontaneous or controlled ventilation) and the anesthetics employed still continue. It is known that rocuronium, which is a non-depolarizing neuromuscular blocking agent, does not cause the release of histamine and has a short duration for the onset of action [14-17].

There is not any study available in which both controlled ventilation is employed and varying doses of rocuronium are evaluated for the rigid bronchoscopy performed in pediatric patients. In our study, we aimed to compare clinical influence and adverse effects of different rocuronium doses such as duration of anesthesia and broncoscophy, body movement, laryngospasm, bronchospasm, hypoxemia in children undergoing pediatric rigid bronchoscopy.

## MATERIAL and METHODS

After receiving the approval of our hospital's ethics committee, the files belonging to the period of 2014-2016 for the pediatric patients who were subjected to the rigid bronchoscopy by the department of pediatric surgery as a result of the foreign body aspiration were evaluated retrospectively.

60 pediatric patients, Grade I-II (American Society of Anesthesiologists (ASA)) and aged 6 months-6 years, who underwent the rigid bronchoscopy for the diagnosis and treatment of the tracheobronchial foreign body aspiration, were included in the study. The patient data including the age (in months), body weight, gender, coexisting diseases, preoperative pneumonia, duration of bronchoscopy (the time from the passage of the rigid bronchoscope through the vocal cord to the retraction of the bronchoscope), duration of anesthesia (the time from the induction of anesthesia to the recovery unit) and additional drugs (atropine, adrenaline, ephedrine, methylprednisolone) were recorded. The fasting times for the children were set as 2 hours for clear liquid, 4 hours for breast milk and 6 hours for infant formula or solid food. Children were excluded from the study if they had cardiovascular disease, cerebral disease, hepatic or renal dysfunction, neuromuscular or congenital metabolic disease.

By connecting the crystalloid fluid via intravenous (iv) peripheral vascular access to the patients who were admitted to the operating room without premedication, the peroperative recordings were performed continuously for the heart rate, electrocardiogram and pulse oxygen saturation ($SpO_2$) and at intervals of five minutes for the non-invasive blood pressure.

All the patients were subjected to monitorization followed by preoxygenation via peripheral vascular access. After administering 1 mg/kg of lidocaine to inhibit the propofol pain, the induction was performed with 2-4 mg/kg of propofol and 1 mcg/kg of remifentanil. The patients were ventilated with 100% oxygen by the use of the masks. 60 patients included in the study were divided into 3 groups according to the administered dose of rocuronium. The patients receiving 0.3 mg/kg (ED95) of rocuronium were included in Group I, the patients receiving 0.45 mg/kg (1.5xED95) of rocuronium were included in Group II and the patients receiving 0.6 mg/kg (2xED95) of rocuronium were included in Group III. Anesthesia maintenance was performed with 3-4% sevoflurane and 6 L/min flow of 100% oxygen by connecting the respiratory circuit to the side part of the broncho-

scope. In the presence of body movement, an additional dose of 1 mg/kg of propofol was administered. Manual Intermittent Positive Pressure Ventilation (MPPV) was commenced through the breathing circuit, which was connected as a T-shaped piece to the side arm of the RB (Karl-Storz, Tuttlingen, Germany). Throughout the rigid bronchoscopy, all the patients were provided with controlled ventilation via MPPV at an airway pressure limit of 20-25 cm $H_2O$ and a frequency of 14-20 times/min. After retracting the rigid bronchoscope, the patients were ventilated with 100% oxygen by the use of the facemasks and then all the patients were allowed to recover by administering 2 mg/kg of sugammadex. In our study, the dose of sugammadex was given 2 mg / kg since the age group of the pediatric patient was under 6 years old. The ventilation with 100% oxygen by the use of the facemasks was continued until the patients achieved full wakefulness and recovered their spontaneous respiration.

In the recovery unit, the patients were monitored and assessed at intervals of 5 minutes for a period of 30 minutes. In case the patients were awake and the room air contained a $SpO_2$ value of ≥92, the patients were transferred to the pediatric surgery intensive care unit. After 4-6 hours in the intensive care unit, the anterioposterior chest x-ray was taken and the postoperative complications (pneumothorax, pneumomediastinum, atelectasia, emphysema, tracheal rupture, etc.) were recorded.

The perioperative adverse events in the course of bronchoscopy were noted as hypoxemia (longer than 15 s and $SpO_2$ ≤90%), bradycardia (≤80 beats/min for infants, ≤70 beats/min for older children), hypotension (20% lower than the baseline blood pressure), body movement, laryngospasm (glottal closure was closed of the vocal cords and examined by stridor or retraction), bronchospasm (prolonged expiratory phase and wheezes). 0.01 mg/kg of atropine (iv) was administered in case of bradycardia, 0.1 mg/kg of ephedrine (iv) was administered in case of hypotension, intubation was performed in the persistent case of $SpO_2$ ≤85% and ≥20 s, and 1 mg/kg of methylprednisolone and/or 1 mcg/kg of adrenaline (iv) was/were administered in case of laryngospasm or bronchospasm.

**Statistical analysis**

The analysis of data was performed using SPSS for Windows 23 package software. While evaluating the study data, descriptive statistics were presented as mean and standard deviation (Mean, SD). Comparison of the quantitative data between the groups was performed by Mann Whitney U test. Comparison of categorical variables between the groups was performed by chi- square test; continuous variables with normal distribution were evaluated using One Way Analysis of Variance, while continuous variables without normal distribution were evaluated using Kruskal-Wallis Variance Analysis. $p<0.05$ was considered to be statistically significant.

## RESULTS

Total 60 patients, 19 female (31.7%) and 41 male (68.3%), with age in the range of 6 months- 6 years (average 25.9±16.6 months) and with average body weight of 12.8±4.6 kg were included in the study. Tracheobronchial foreign body was found in 60 children (100%). More than half of foreign bodies (n=38) (63,4%) were found in the right bronchial tree, while the remaining foreign bodies (n=22) (36.6%) were found in the left bronchial tree. Most of the foreign bodies (88,3%) were organic, such as peanuts, hazelnuts, watermelon seeds and pine nuts; others were inorganic, such as beads, pins, buttons and needles. The average time that elapsed before admitting to the hospital was learnt to be 5.2 days (1-9 days).

The average duration of bronchoscopy was found to be 14.2±3.9 minutes and the average duration of anesthesia was found to be 20.3±5.3 minutes. ASA scores were as follows: ASA I group included a total of 51 patients (85%) and ASA II group included a total of 9 patients (15%). The evaluation of the patients in terms of the preoperative pneumonia

revealed that the preoperative pneumonia was present in a total of 3 patients (5%). As for the distribution of the preoperative pneumonia among the groups, the pneumonia was detected in 2 patients (9%) in Group I and in 1 patient (5%) in Group II. No significant difference was found among the groups in terms of age, height, weight, bronchoscopy duration, ASA distribution and presence of preoperative pneumonia; and when the groups were evaluated with regard to the duration of anesthesia, the patients subjected to bronchoscopy in Group III were found to have significantly longer durations of anesthesia as compared to those in Groups I and II (Table 1).

When the 3 groups were evaluated based on the perioperative hemodynamic parameters, no statistically significant difference was found in terms of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP) and $SpO_2$ ($p>0.05$). The body movement was observed in 19 patients (31.7%) and it did not occur in the remaining 41 subjects (68.3%). An evaluation of the distribution of the body movement among the groups revealed that, of 19 patients, 18 were in Group I and only 1 was in Group II. Based on the distribution of the body movement among the groups, the body movement in Group I was found to be statistically higher (Table 2).

Bronchospasm was observed in 11 patients (18.3%) all of whom were in Group I. Hypoxemia, detected in 9 (15%) out of all the patients, was observed only in Group I, as in the case with bronchospasm. Laryngospasm was observed in 16 patients (26.7%). Of these patients, 15 were in Group I, while only 1 was in Group II. When the groups were compared with regard to hypoxemia, bronchospasm and laryngospasm, these adverse events were found to be significantly greater in number in Group I than the other groups (Table 2). No complication associated with bronchoscopy, such as pneumothorax, pneumomediastinum, emphysema and tracheal rupture, was detected in the postoperative evaluation of chest x-rays. The postoperative atelectasia was detected in 3 out of all the patients (5%). Of these patients, 2 (9%) were in Group I, while 1 was in Group II. The comparison among the groups in terms of postoperative atelectasia revealed no significant difference ($p>0.05$).

**Table 1. Demographic and other data for the groups.**

| | Group I (n=21) | Group II (n=19) | Group III (n=20) | p level |
|---|---|---|---|---|
| Gender (female/male) | 7/14 | 7/12 | 5/15 | 0.725 |
| Age (months) | 27±17 | 24±15 | 25±16 | 0.830 |
| Body weight (kg) | 13.5±6.3 | 12.2±4.0 | 12.6 ±3.0 | 0.679 |
| ASA I/II | 18/3 | 15/4 | 18/2 | 0.636 |
| Duration of bronchoscopy (minutes) | 13.8±2.8 | 13.6±3.6 | 15.4±5.1 | 0.289 |
| Duration of anesthesia (minutes) | 19.8±4.3 | 19.5±5.6 | 21.7±5.7 | **0.014** |

**Table2. Perioperative adverse events in the groups**

| | Group I (n=21) | Group II (n=19) | Group III (n=20) | p level |
|---|---|---|---|---|
| Patients with body movement | 18 | 1 | - | ***0.001*** |
| Patients with laryngospasm | 15 | 1 | - | ***0.001*** |
| Patients with bronchospasm | 11 | - | - | ***0.001*** |
| Patients with hypoxemia | 9 | - | - | ***0.001*** |
| Patients with preoperative pneumonia | 2 | 1 | - | 0.636 |
| Patients with postoperative atelectasia | 2 | 1 | - | 0.388 |

Regarding the additional drugs, these were observed to be administered to a total of 23 patients (38.3%). Of these 23 patients, 3 were administered atropine (5%), 9 were administered steroid (15%), and 14 were administered adrenaline and steroid (23.3%). No additional drug was administered to remaining 37 patients (61.7%). In Group I, one patient was administered atropine, 6 patients were administered steroid and 14 patients were administered steroid and adrenaline. In Group II, one patient needed atropine administration and 1 patient needed steroid administration. In the evaluation of the groups in terms of the additional drug administrations, it was observed that all the patients in Group I were administered additional drugs and the use of additional drugs in Group I was significantly higher than the other groups ($p<0.05$).

## DISCUSSION

The foreign body aspiration is a serious life-threatening condition that generally occurs in children under the age of 3 years. In this study, we evaluated the effects and complications following the administration of rocuronium in a varying dose range as the neuromuscular blocker along with the controlled ventilation in the pediatric patients undergoing the rigid bronchoscopy that was performed due to the foreign body aspiration. In our study of pediatric rigid bronchoscopic showed that intravenous introduction of propofol-remifentanil combined with 0.45 mg/kg rocuronium and sugammadex is a safe and effective choice on the ventilation.

The durations of operation and anesthesia for the foreign body aspiration vary with the method of ventilation or anesthesia employed. Literature reports the durations varying in the range of 8,5-25 minutes for the operation and in the range of 9-21 minutes for the anesthesia [4-6,12]. For our patients, who were administered varying doses of rocuronium as the neuromuscular blocker along with controlled ventilation and were reversed with sugammadex, the durations of operation were at the upper limit of the range of durations reported in literature, whereas the durations of anesthesia were observed to be close to the lower limit. The short durations of anesthesia were considered to be associated with the reversal of our patients with sugammadex. On the other hand, the durations of anesthesia were found to be longer in the patients in rocuronium 0.6 mg/kg. It is seen that the dose of sugammadex administered in pediatric patients is used in different doses. A safe and effective dose of sugamadex in reversing neuromuscular blockade for pediatric patients is not obvious in studies. The dose of sugammadex is not available specific pediatric dosing guidelines for rocuronium doses. In the literature the dose 2-4 mg / kg of sugammadex is generally used for pediatric patients [18,19]. Sugammadex appears to reverse deep neuromuscular blockade in patients less than 2 years of age but reliable train-of-four data were limited. In our study, 2 mg / kg sugammadex was used in a patient group less 6 years old, and the dose range is similar to the literature. No study was found in literature regarding the effects of such dose variation on the durations of anesthesia for the pediatric patients.

Referring to literature in terms of the bronchospasm, laryngospasm and low saturation encountered during the procedure, the low saturation is frequently observed and reported in the pediatric patients undergoing bronchoscopy with spontaneous ventilation because of the foreign body aspiration [2-4]. In another study involving the bronchoscopy with spontaneous ventilation, laryngospasm and bronchospasm were observed in very few patients when dexmedetomidine was used [6]. In another study related to the pediatric foreign body aspiration comparing remifentanil with sevoflurane, the side effects like bronchospasm and laryngospasm were observed more frequently in the group receiving remifentanil, where laryngospasm and bronchospasm were observed at the frequencies of 17,3% and 9,1%, respectively [4]. Based on these side effect frequencies reported in literature, these complications were frequently encountered in the patients in our study,

who were administered the low dose of rocuronium, whereas said complications were almost non- existing in the other groups receiving higher doses. On the other hand, the postoperative complications reported in literature such as tracheotomy [2-6] were not detected in any of our patient groups.

Both spontaneous ventilation and controlled ventilation are the methods suitable for the removal of the foreign body. Although the ability to more rapidly respond to any problem occurring in relation to ventilation is considered an advantage of the spontaneous ventilation method, the involuntary movements resulting from inadequate anesthetic depth constitute the major drawback of this method [2,3,12]. And also in a study evaluating the body movement in case of using dexmedetomidine during the rigid bronchoscopy carried out in the children with foreign body aspiration, the body movement was reported to be detected in 10% of the patients [5]. In the present study in which we evaluated the body movement by administering varying doses of rocuronium, it was observed that the body movement was much higher in the patients in Group I who were administered the lowest dose.

As a result of the airway reflexes not being suppressed due to the absence of use of the neuromuscular blockers in cases where the spontaneous ventilation is preferred for a shorter bronchoscopy, the conditions like laryngospasm, hypoxia and body movement render the procedure more difficult to perform [2,9,10,12]. Succinylcholine is often preferred due to the shorter procedure duration in the patients for whom the controlled ventilation is chosen, whereas additional doses or other short-acting neuromuscular blockers are needed in cases such as the prolonged procedure or emergency tracheostomy [13]. Further, only a limited number of studies were found in literature about the use of the varying doses of rocuronium in pediatric patients. In a study comparing the rocuronium doses of 0,45 mg/kg and 0,6 mg/kg for the pediatric patients undergoing elective surgery, it was recommended to prefer the lower dose for the pediatric patient group, because the patient group receiving the higher dose had longer time of action, the lower dose allowed a faster and better relaxation as well as a more successful intubation, and no prolongation was observed in the termination of action in case of using the lower dose [14]. In another study using 0,45 mg/kg rocuronium as the neuromuscular blocker, it was recommended to use this low dose for the pediatric patients since it provided the most suitable conditions for intubation and further, caused no significant hemodynamic change [15]. In another pediatric study involving the administration of varying doses of rocuronium, the evaluation of the efficacy and side effects for the use of five different doses (0.15, 0.22, 0.3, 0.5, 1 mg/kg) resulted in the observation that the use of the low dose provided an improvement in the state of intubation and further enabled a faster recovery of muscle strength [16]. A retrospective review of cases of pediatric rigid bronchoscopic showed that intravenous introduction of propofol-remifentanil combined with rocuronium is a safe and effective choice under pressure-control ventilation [17]. In our study, we showed that safety clinical efficacy and less perioperative adverse events by giving doses of rocuronium 0.45 mg/kg and 2 mg/kg sugammadex in our pediatric patients who underwent rigid bronchoscopy.

## CONCLUSION

There is no general agreement present regarding the choice of the safe anesthetic technique for the rigid bronchoscopy employed for the diagnosis and treatment of the tracheobronchial foreign body aspiration. In addition, appropriate anesthesia agents can play an important role in decreasing critical complications. Rocuronium administered at the dose of 0.45 mg/kg and 2 mg/kg sugammadex to a group of patients in our study resulted in more effective ventilation, better perioperative and postoperative stability and fewer complications so that this dose is most suitable for the rigid bronchoscopy performed in the pediatric patients. In the meantime, we believe that performing the studies of rigid bron-

choscopy with different age groups, varying doses and different neuromuscular blocking agents would make a contribution to literature.

## REFERENCES


1. Chadha M, Kulshrestha M, Biyani A. Anaesthesia for bronchoscopy. Indian J Anaesth. 2015 Sep; 59(9):565-73. https://doi.org/10.4103/0019-5049.165851
2. Mashhadi L, Sabzevari A, GharaviFard M,Shojaeian R, Salehi M, Joodi M, et al. Controlled vs Spontaneous Ventilation for Bronchoscopy in Children with Tracheobronchial Foreign Body. Iran J Otorhinolaryngol. 2017 Nov; 29(95):333-40. PMID: 29383314
3. Kendigelen P. The anaesthetic consideration of tracheobronchial foreign body aspiration in children. J Thorac Dis. 2016 Dec; 8(12):3803-7. https://doi.org/10.21037/jtd.2016.12.69
4. Chai J, Wu XY, Han N, Wang LY, Chen WM. A retrospective study of anesthesia during rigid bronchoscopy for airway foreign body removal in children: propofol and sevoflurane with spontaneous ventilation. Paediatr Anaesth. 2014 Oct; 24(10):1031-6. https://doi.org/10.1111/pan.12509
5. 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 Nov; 23(11):1048-53. https://doi.org/10.1111/pan.12197
6. Liao R, Li JY, Liu GY. Comparison of sevoflurane volatile induction/maintenance anaesthesia and propofol-remifentanil total intravenous anaesthesia for rigid bronchoscopy under spontaneous breathing for tracheal/bronchial foreign body removal in children. Eur J Anaesthesiol. 2010 Nov; 27(11): 930-4. https://doi.org/10.1097/EJA.0b013e32833d69ad
7. Zhang X, Li WX, Cai YR. A time series observation of Chinese children undergoing rigid bronchoscopy for an inhaled foreign body: 3,149 cases in 1991-2010. Chin Med J (Engl). 2015 Feb 20; 128(4):504-9. https://doi.org/10.4103/0366-6999.151104
8. Farrell PT. Rigid bronchoscopy for foreign body removal: anaesthesia and ventilation. Paediatr Anaesth. 2004 Jan; 14(1):84-9. https://doi.org/10.1046/j.1460-9592.2003.01194.x
9. Teksan L, Baris S, Karakaya D, Dilek A. A dose study of remifentanil in combination with propofol during tracheobronchial foreign body removal in children. J Clin Anesth. 2013 May; 25(3):198-201. https://doi.org/10.1016/j.jclinane.2012.10.008
10. Liu J, Xiao K, Lv X. Anesthesia and ventilation for removal of airway foreign bodies in 35 infants. Int J Clin Exp Med. 2014 Dec 15; 7(12):5852-6. PMID: 25664119
11. Bakan M, Topuz U, Umutoglu T, Gundogdu G, Ilce Z, Elicevik M, et al. Remifentanil-based total intravenous anesthesia for pediatric rigid bronchoscopy: comparison of adjuvant propofol and ketamine. Clinics (Sao Paulo). 2014 Jun; 69(6):372-7. https://doi.org/10.6061/clinics/2014(06)01
12. Fidkowski CW, Zheng H, Firth PG. The anesthetic considerations of tracheobronchial foreign bodies in children: a literature review of 12,979 cases. Anesth Analg. 2010 Oct; 111(4):1016-25. https://doi.org/10.1213/ANE.0b013e3181ef3e9c
13. Annigeri RV, Patil RS. A Retrospective Analysis on Anesthetic Management during Rigid Bronchoscopy in Children with Foreign Body Aspiration: Propofol and Sevoflurane with Controlled Ventilation. Anesth Essays Res. 2017 Oct-Dec; 11(4):871-4. https://doi.org/10.4103/aer.AER_154_17
14. Rapp HJ, Altenmueller CA, Waschke C. Neuromuscular recovery following rocuronium bromide single dose in infants. Paediatr Anaesth. 2004 Apr; 14(4):329-35. https://doi.org/10.1046/j.1460-9592.2003.01216.x
15. Bartolek D, Lajtman Z, Zdravcević-Sakić K, Jakobović J, Bartolek F, Cavrić G. The optimal pediatric induction dose of propofol in combination with reduced-dose rocuronium and alfentanil for day-case tonsillectomy in children. Int J Pediatr Otorhinolaryngol. 2007 Dec; 71(12):1873-81. https://doi.org/10.1016/j.ijporl.2007.08.016
16. Eikermann M, Renzing-Köhler K, Peters J. Probability of acceptable intubation conditions with low dose rocuronium during light sevoflurane anaesthesia in children. Acta Anaesthesiol Scand. 2001 Sep; 45(8):1036-41. https://doi.org/10.1034/j.1399-6576.2001.450819.x
17. Qiu Y, Qu J, Li X, Li H. Anesthesia with propofol-remifentanil combined with rocuronium for bronchial foreign body removal in children: Experience of 2 886 cases. Pediatr Investig. 2018 May; 11;2(1):25-9. https://doi.org/10.1016/j.jclinane.2016.04.033
18. Franz AM, Chiem J, Martin LD, Rampersad S, Phillips J, Grigg EB. Case series of 331 cases of sugammadex compared to neostigmine in patients under 2 years of age. Paediatr Anaesth. 2019 Jun;29(6):591-6. https://doi.org/10.1111/pan.13643
19. Gaver RS, Brenn BR, Gartley A, Donahue BS. Retrospective aanalysis of the safety and efficacy of sugammadex versus neostigmine for the reversal of neuromuscular blockade in children. Anesth Analg. 2019 Oct;129(4):1124-9. https://doi.org/10.1213/ANE.0000000000004207