



Research Article/Özgün Araştırma

Comparison of the effects of sugammadex and neostigmine on recovery of anesthesia in rigid bronchoscopy in pediatric cases

Pediyatrik olgularda uygulanan rijit bronkoskopi işleminde anestezi derlemesinde sugammadex ve neostigminin etkinliğinin karşılaştırılması

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Abstract

Aim: To compare the efficacy of sugammadex and neostigmine, which are used to reverse rocuronium-neuromuscular blockade in children who underwent rigid bronchoscopy due to tracheobronchial foreign body aspiration.

Materials and Methods: The data of 54 patients who underwent rigid bronchoscopy with the suspicion of foreign body aspiration in children aged 0-18 in our hospital between 2013 and 2018 were retrospectively analyzed.

Results: Thirty of the cases were male and 24 were female. Atropine-neostigmine was administered to 23 patients and sugammadex was administered to 31 patients to reverse neuromuscular blockade. While no complications were found in 41 cases, bronchospasm was found in 6 cases, hypoxia in 5 cases, and laryngospasm in 2 cases. Recovery time was shorter in patients who received sugammadex ($p<0.001$).

Conclusion: Recovery time is shorter after sugammadex administration in reversing rocuronium-induced neuromuscular blockade in pediatric rigid bronchoscopy anesthesia.

Keywords: Pediatric Rigid Bronchoscopy; Sugammadex; Rocuronium; Neostigmine

Öz

Amaç: Trakeobronşiyal yabancı cisim aspirasyonu nedeniyle rijit bronkoskopi yapılan çocuklarda roküronyumun neden olduğu nöromüsküler blokajın tersine çevrilmesinde kullanılan sugammadex ve neostigminin etkinliğinin karşılaştırılması amaçlanmıştır.

Gereç ve Yöntem: Hastanemizde 2013-2018 tarihleri arasında 0-18 yaş grubu çocuklarda, yabancı cisim aspirasyonu şüphesi ile rijit bronkoskopi yapılan 54 hastanın verileri geriye dönük olarak incelendi.

Bulgular: Olguların 30'u erkek, 24'ü kızdı. Nöromüsküler blokajın tersine çevrilmesi amacıyla, 23 olguya atropin- neostigmin ve 31 olguya da sugammadex uygulanmıştı. 41 olguda komplikasyon saptanmazken 6 olguda bronkospazm, 5 olguda hipoksi, 2 olguda laringospazm saptandı. Derlenme süresi sugammadex uygulanan olgularda daha kısa tespit edilmiştir ($p<0,001$).

Sonuç: Pediyatrik rijit bronkoskopi anestezi uygulamasında roküronyumun neden olduğu nöromüsküler blokajın tersine çevrilmesinde, sugammadex uygulanması sonrası derlenme süresi daha kısadır.

Anahtar Kelimeler: Pediyatrik rijit bronkoskopi, Sugammadex, Roküronyum, Neostigmin.

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Introduction

Foreign body aspiration (FBA) is one of the most common emergencies in childhood. While they may be asymptomatic, they can cause serious respiratory complications and even death. FBA is the leading cause of accidental death in children younger than one year of age.¹

Bronchoscopy in children has many difficulties. The main of these difficulties are that hunger of patients is not suitable, uncooperative and narrow airway of patients causing oxygenation and ventilation disorders. The patients' head and neck region is used by the surgeon and anesthesiologist simultaneously.²⁻⁴

Anesthesia management during bronchoscopy is of great importance in reducing the risk of life-threatening perioperative and postoperative complications such as laryngeal edema, laryngospasm, bronchospasm, airway laceration, tracheal rupture, pneumothorax, atelectasis.⁵ This can be prevented with neuromuscular blocking drugs or a deep level of anesthesia.⁶

For this reason, the most commonly used neuromuscular blocking drug is rocuronium with steroid structure. Neostigmine and recently sugammadex, one of the new agents with good pharmacokinetic profile, have been used to reverse the effect of rocuronium at the end of the procedure. The residual blocking effect of neostigmine may cause complications such as respiratory depression and hypoxemia.⁷ Sugammadex bind the rocuronium by encapsulation method, reduces the plasma level of rocuronium and ensuring its excretion with urine.^{7,8}

The aim of our study is to compare the efficacy of sugammadex and neostigmine used in reversing rocuronium-induced neuromuscular blockade in children undergoing rigid bronchoscopy due to tracheo-bronchial FBA and to evaluate postoperative complications.

Materials and Methods

The type of the research

This research was a retrospective observational study, which was conducted in Adiyaman training and research hospital.

The samples of the research

A total of 54 patients were included in the study (30 men, 24 women). The medical records of children aged 0-18 years who underwent rigid bronchoscopy for diagnosis and treatment in the operating room of our hospital between January 2013 and December 2018 for suspected FBA were retrospectively reviewed.

Data collection tools

The records of the cases included gender, age, complaint of admission to the hospital, anesthesia induction and maintenance, level of foreign body obstruction (trachea, right main bronchus, left main bronchus), drugs used for recovery from anesthesia, duration of the procedure, recovery times, complications encountered, terms of length of hospital stay.

Cases with insufficient data, patients supported by spontaneous breathing, patients who did not use rocuronium as a neuromuscular blocker, patients who were taken to intensive care were not included in the study.

Data analysis

Data analyzes were carried out using SPSS 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Mean±standard deviation, minimum and maximum values for continuous data as descriptive statistics; for categorical data, frequency and percentage were used. The conformity of the variables to the normal distribution was evaluated using the Kolmogorov-Smirnov test, skewness- kurtosis values, and histograms. The frequencies, rates, mean and standard deviations of the patients in terms of different variables are presented as descriptive statistics. Whether the distributions of the research variables meet the normality assumption was evaluated with both skewness and kurtosis levels and the results of Shapiro-Wilk and Kolmogorov-Smirnov tests. Evaluation results show that research variables do not meet the normality assumption. For this reason, the Mann Whitney U test, which is one

of the non-parametric tests, was used in the comparison analysis. In comparison groups, median and Q1 and Q3 values were included. Chi-square Analysis and crosstabs were used to examine the differences between the proportional distributions of categorical data. The level of significance for the analysis results was determined as $p < 0.05$.

The ethical aspect of research

The study was started after the approval of the Non-Invasive Clinical Research Ethics Committee of Adıyaman University with the date of 19.11.2019 and the decision number 2019/8-13. The research has been prepared in accordance with the Declaration of Helsinki Principles.

Intraoperative procedures

Patients who underwent routine monitoring procedure were administered methylprednisolone at a dose of 1 mg/kg and midazolam at a dose of 0.01 mg/kg/iv. For anesthesia induction, propofol at a dose of 2.5 mg/kg/iv, rocuronium at a dose of 0.6 mg/kg/iv, and fentanyl at a dose of 1 mcg/kg/iv were administered. Inhaled 2-2.5 % sevoflurane and 0.5-1 mcg/kg/minute/iv remifentanyl infusion were used for anesthesia maintenance. All bronchoscopy procedures were performed by pediatric surgeons. During rigid bronchoscopy, respiratory support was provided with intermittent positive pressure ventilation using a catheter mount from the side connection of the bronchoscope device. After the procedure was terminated, atropine plus neostigmine (0.03 mg/kg/iv dose) or sugammadex (2-4 mg/kg/iv dose) was administered to reverse neuromuscular blockade. The cases in which neostigmine was used to reverse the neuromuscular blockade caused by rocuronium applied in intraoperative anesthesia were defined as Group N, and the cases in which sugammadex was used as Group S. Duration of anesthesia; the time from the patient's transfer to the operating table until the patient's transfer to the post-operative care unit (PACU), Procedure time; time from the first insertion of the rigid bronchoscope tip into the patient's mouth to removal of the bronchoscope from the vocal cords, recovery time was defined as the time from the end of

the rigid bronchoscopy procedure to PACU admission. Cases where there was no organic or inorganic material but only secretion or mucus plug during bronchoscopy were evaluated as 'no foreign body'.

Results

A total of 54 patients were included in the study (30 men, 24 women). The mean age was 4.17 ± 4.7 years in Group N and 2.8 ± 3.8 years in Group S. Statistically, there was no difference in age between the groups ($p = 0.546$).

When the application complaints were examined, there was at least one complaint in 47 (87.5%) cases (Table 1). The most common complaint was cough (38.1%) and the least complaint was difficulty in swallowing (3.7%) (Graph 1). There was no complaint in 7 cases (12.5%) (Table 1).

Table 1. Application complaints of the cases.

Additional complaint	n	%	
Cough	yes	33	61.1
	no	21	38.9
Respiratory distress	yes	13	24.1
	no	41	75.9
Bruising	yes	22	40.7
	no	32	59.3
Growling	yes	7	13
	no	47	87
Difficult swallowing	yes	2	3.7
	no	52	96.3
Total	yes	47	87.5
	no	7	12.5

When Group N and Group S were compared in terms of age, anesthesia duration, duration of procedure, recovery time and hospital stay, it was seen that Group N recovery time mean rank was significantly higher than Group S recovery time mean rank, $z(52) = -5.62$, $p < 0.001$.

However, there was no significant difference between the mean rank of the groups in terms of age, duration of anesthesia, duration of procedure and hospital stay ($p > 0.05$) (Table 2).

After rigid bronchoscopy, in 41 (75.9%) cases no complications was observed. In group N; in 4 (17.4%) cases bronchospasm, in 4 (17.4%) cases hypoxia was observed. In group S in 2 (6.5%) cases bronchospasm, in 1 (3.2%)

cases hypoxia and in 2 (6,5%) cases laryngospasm was observed. (Table 3).

Table 2. Age, duration of anesthesia, duration of procedure, duration of recovery and duration of hospitalization of the cases using neostigmine and sugammadex.

Variables	Group	n	Mean±SD	Rank av.	Median	IQR(25-75)	p
Age(year)	N	23	4.17±4.7	28.89	2	1-9	0.546
	S	31	2.8±3.8	26.47	1	1-2	
Anesthesia Time(minute)	N	23	58.3±21	29.30	50	45-70	0.463
	S	31	53.8±16.5	26.16	50	40-70	
Process Time(minute)	N	23	39.8±16.9	27.04	35	30-50	0.854
	S	31	39.5±15.8	27.84	38	28-50	
Recovery Time(minute)	N	23	16.4±4.2	41.33	15	13-20	<0.001
	S	31	10±2	17.24	10	8-12	
Hospital Time(day)	N	23	2.6±1.1	24.74	2	2-3	0.245
	S	31	3±1.3	29.55	3	2-4	

Values are median (25-75 IQR), Mean±SD:mean±standard deviation

Table 3. Complications.

Complication	Group N(n/%)	Group S(n/%)	p
Bronchospasm	4(17.4)	2(6.5)	0.095
Hypoxia	4(17.4)	1(3.2)	
Laryngospasm	0	(6.5)	
Total	54	100	

Although the complication rate was lower in Group S, there was no significant difference between the groups ($p>0.05$) (Table 4). Foreign body was found in 41 (75.9%) of the cases. Thirty (55.5%) of the foreign bodies were organic and 11 (20.4%) were inorganic (Table 5).

Table 4. Distribution of complication rates by groups n (%).

Complication	No	Yes	Total	p
Group N	15 (65.2)	8 (34.8)	23	0,113
Group S	26(83.9)	5(16.1)	31	
Total	41(75.9)	13(24.1)	54	

Table 5. Nature and localization of foreign bodies.

Nature of the Object	n (%)
organic	30 (55.5)
inorganic	11(20.4)
No foreign body	13 (25.1)
Foreign Body Location	
Main Trachea	7 (13)
Left main bronchus	16 (29.6)
Right main bronchus	18 (33.3)
No foreign body	13 (24.1)
Total	54 (100)

There was no foreign body found in 13 (24.1%) patients. It was found in the right main bronchus in 18 (33.3%) cases, in the left main

bronchus in 16 (37%) cases, and in the trachea in 7 (13%) cases (Table 5).

Discussion

Tracheobronchial foreign body aspiration in childhood continues to be an important cause of morbidity and mortality.¹ Delays in diagnosis and treatment can cause severe pulmonary damage and fatal complications; so that urgent intervention is required.^{9,10} The gold standard method for the diagnosis and treatment of this condition is rigid bronchoscopy.¹¹⁻¹² Cough, shortness of breath, hoarseness and wheezing in the first period are among the reasons for admission to FBA; obstructive emphysema, lung abscess, atelectasis, empyema, pneumothorax, and bronchiectasis can be seen among the late-term findings.^{5,13,14} In our study, we encountered the most common complaints of cough, shortness of breath and bruising. The mean age of patients was 3.3

There was no foreign body found in 13 patients. According to the study of Karaaslan and Yıldız¹³ while foreign body was found in 71 patients, no foreign body was found in 29 patients. The extracted foreign bodies were mostly localized in the main bronchus (n=35, 43.3%), followed by the larynx/trachea (n=20, 24.6%) and the left main bronchus (n=16, 19.7%).¹³ In our study, it was found to be in the right bronchus in 18 (33.3%) cases, in the left bronchus in 16 (37%) cases, and in the trachea in 7 cases. There was no foreign body in 13 (24.1%) (Table 5).

Neuromuscular blockade is a routine method used worldwide in the management of general anesthesia to facilitate endotracheal intubation and to keep the patient still during surgery. However, even in those with moderate duration of action of neuromuscular blocking agents, the most important risk is postoperative recurarization.¹⁵ Sugammadex at doses of 2.0 mg/kg or higher safely reverses 0.6 mg/kg rocuronium-induced neuromuscular block in a dose-dependent manner, and the sugammadex-rocuronium complex is excreted unchanged by the kidneys.¹⁶ Sugammadex binds rocuronium molecules in a 1:1 ratio without affecting plasma cholinesterase or muscarinic receptors. Muscarinic effects such as miosis, bradycardia, bronchospasm, increased secretions, and nausea-vomiting do not occur from its use.¹⁷ Compared with neostigmine, sugammadex was faster in reversing neuromuscular block, extubated earlier, and had a lower risk of postoperative residual curarization after extubation, in a meta-analysis of 1384 patients from 13 articles by Carron et al.¹⁸

In a comparison study of sugammadex and neostigmine it was found that the mean recovery and extubation times were shorter in sugammadex and incidence of nausea, vomiting, tachycardia were higher in neostigmine.¹⁹ Li et al.²⁰ reported that extubation time and length of hospital stay shorter, hospitalization expenses were decreased and postoperative atelectasis was less in sugammadex. Won et al.²¹ reported that although there was no significant difference in the incidence of adverse events in pediatric patients, sugammadex provided a faster reversal of rocuronium-induced neuromuscular blockade and a shorter extubation time compared to atropine-neostigmine. Mogahed, et al.²² reported that sugammadex reversed the effect of rocuronium significantly faster than neostigmine. In our study, recovery time was 10 minutes in patients using sugammadex and 16.4 minutes in patients using Neostigmine. Similar to the literature, the recovery time was found to be shorter in the sugammadex group.

In the study of Karaaslan and Yıldız¹³ the most common complications among perioperative complications were desaturation

and bradycardia. In the study of Korkmaz et al.²³ in which sugammadex and neostigmine were compared in adenotonsilectomy operations, postoperative agitation rates and complication rates were found to be lower in the sugammadex group. In a case series of 331 case of sugammadex in patients under 2 years of age, no adverse effects were reported.²⁴

In our study, the most common complications were bronchospasm and desaturation. When complications were compared between the groups, although complications were higher in the neostigmine group, there was no statistical difference. In the review where the mortality rates in foreign body aspiration were analyzed, the mortality rate was found to be between 0-1.06% in 9 studies conducted in Europe, and between 0-1.8% in 22 studies conducted in Asia.¹ No mortality was observed in our study.

Limitations of the study; the retrospective nature of the study and the small number of cases constitute the main limitations of our study.

Conclusion

The use of sugammadex in reverse neuromuscular blockade in rigid bronchoscopy has a shorter recovery time and less complication rate than the use of neostigmine.

Ethics Committee Approval

The study was approved by the Non-Invasive Clinical Research Ethics Committee of Adıyaman University with the date of 19.11.2019 and the decision number 2019/8-13. The research has been prepared in accordance with the Declaration of Helsinki Principles.

Author Contributions

Idea, design: M.D., H.Ö.A., M.Ş.M., M.D., M.T., Ç.D.; collection of resources: M.D., H.Ö.A., M.Ş.M., M.D., M.T.; analysis and interpretation of results and literature: M.D., H.Ö.A., M.T., Ç.D.; written and critical: M.D., H.Ö.A., M.Ş.M., M.D., M.T., Ç.D.

Conflict of Interest

There is no conflict of interest among the authors.

Financial Disclosure

There is no financial disclosure.

Statements

These research results have not previously been presented.

Peer-review

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