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Original Article

Effect of Different Doses of Sugammadex on Recovery and Hemodynamic Parameters in Reversing Neuromuscular Blockade in Patients Undergoing Electroconvulsive Therapy

Elektrokonvülsif Tedavi Uygulanan Hastalarda Nöromusküler Blokajın Geri Döndürülmesinde Sugammadeksin Farklı Dozlarının Derlenme ve Hemodinamik Parametrelere Etkisi

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ABSTRACT

Objective: This retrospective observational study aimed to investigate the effect of different doses of sugammadex used in reversing neuromuscular blockade in electroconvulsive therapy (ECT) procedures on patient recovery and hemodynamic measurements.

Methods: Anesthesia induction was performed using propofol (1 mg/kg) and rocuronium (0.4 mg/kg). Patients were classified into group 2 (2 mg/kg) and group 3 (3 mg/kg) according to the dose of sugammadex used to reverse neuromuscular blockade. The patient's spontaneous breathing time, eye-opening time, time to comply with voluntary commands, time to reach Modified Aldrete score (MAS) 9, complications, and hemodynamic data were analyzed.

Results: In total, 314 ECT sessions were performed on 46 patients. The average age of the patients was 38.3±12.6 years, and 56.6% (n=26) were male. While the average number of ECTs applied to the patients was 6.8±2.8, the average seizure duration was 28.2±12.7 seconds. The most common diagnosis (32.7%) in patients who underwent ECT was bipolar disorder. The average time to recovery of spontaneous breathing, eye-opening time, time to comply with voluntary commands, and time to reach MAS 9 were found to be significantly lower in group 3 ($p<0.001$, $p<0.001$, $p<0.001$, and $p=0.002$, respectively). Tooth damage was observed in 0.3% (n=1) and tongue abrasion in 0.6% (n=2) of the cases. Hemodynamic measurements were similar between groups ($p>0.05$).

Conclusions: Sugammadex used at a dose of 3 mg/kg in ECT procedures significantly reduces recovery times compared with 2 mg/kg. However, both doses can be safely and cost-effectively used to reverse the neuromuscular blockade provided by 0.4 mg/kg rocuronium.

Keywords: Electroconvulsive therapy, neuromuscular blocking agents, rocuronium, sugammadex, anesthesia recovery

ÖZ

Amaç: Retrospektif gözlemsel bu çalışmanın amacı, elektrokonvülsif tedavi (EKT) işlemlerinde nöromusküler bloğun tersine çevrilmesinde kullanılan farlı sugammadeks dozlarının, hastaların derlenme ve hemodinamik ölçümlerine olan etkisini araştırmaktır.

Yöntemler: Anestezi indüksiyonu propofol (1 mg/kg) ve rokuronyum (0,4 mg/kg) ile gerçekleştirildi. Hastalar nöromusküler blokajın geri döndürülmesinde kullanılan sugammadeks dozuna göre grup 2 (2 mg/kg) ve grup 3 (3 mg/kg) olarak sınıflandırıldı. Hastaların spontan solunum süresi, göz açma süresi, istemli komutlara uyma süresi ve Modifiye Aldrete skoru (MAS) 9'a ulaşma süreleri, komplikasyonlar ve hemodinamik verileri analiz edildi.

Bulgular: Toplamda 46 hastaya 314 seans EKT gerçekleştirildi. Hastaların yaş ortalaması 38,3±12,6 yıl ve %56,6'sı (n=26) erkekti. Hastalara uygulanan ortalama EKT sayısı 6,8±2,8 iken ortalama nöbet süresi 28,2±12,7 saniye saptandı. EKT uygulanan hastalardaki en sık (%32,7) tanı bipolar bozukluk idi. Ortalama spontan solunumun geri gelme süresi, göz açma süresi, istemli komutlara uyma süresi ve Modifiye Aldrete skoru 9'a ulaşma süresi grup 3'te anlamlı olarak düşük saptandı (sırasıyla $p<0,001$, $p<0,001$, $p<0,001$ ve $p=0,002$). Olguların %0,3'ünde (n=1) diş hasarı ve %0,6'sında (n=2) dilde sıyrık gözlendi. Gruplar arasında hemodinamik ölçümler benzerdi.

Sonuçlar: EKT işlemlerinde 3 mg/kg dozda kullanılan sugammadeks, 2 mg/kg doza göre derlenme sürelerini anlamlı olarak düşürmektedir. Bununla birlikte 0,4 mg/kg rokuronyum ile sağlanan nöromusküler blokajın geri çevrilmesinde her iki dozun da güvenli ve maliyet etkin olduğunu düşünüyoruz.

Anahtar kelimeler: Elektrokonvülsif tedavi, nöromusküler bloker ajanlar, rokuronyum, sugammadeks, anestezi derlenmesi

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INTRODUCTION

Electroconvulsive therapy (ECT) is an effective treatment method for many psychiatric disorders that do not respond to psychopharmacological treatments, such as major depressive disorder, catatonia, schizophrenia, and bipolar disorder. Although its mechanism of action is not fully known, it is believed to be based on the stimulation of hypothalamic-pituitary structures and the induction of seizures through electrical stimulation. Although seizures induced by ECT generally cause adverse and temporary effects on memory and cognitive functions, the effectiveness of the treatment is related to the duration of the seizure and the dose of stimulus above the seizure threshold[1].

Because injuries to the extremities and vertebrae and damage to the tongue and teeth can often occur due to tonic-clonic contractions during ECT, the procedure is performed under general anesthesia with neuromuscular blockade. Avoiding anesthesia-related complications by reversing neuromuscular blockade after short-term procedures such as ECT is essential. Although succinylcholine is used for this purpose as a short-acting neuromuscular blocker, undesirable conditions such as myalgia, headache, hyperkalemia, increased intragastric and intraocular pressure, and prolonged effects in people with pseudocholinesterase enzyme deficiency have limited its use[2,3]. With the widespread use of sugammadex, which quickly reverses the effect of steroidal neuromuscular blockers (rocuronium and vecuronium) at the receptor level, the rocuronium-sugammadex combination has become popular in short-term procedures such as ECT[4].

Although sugammadex is used in doses of 2-4 mg/kg, it has been stated that the dose can be increased up to 16 mg/kg in emergencies[5]. Although there are limited studies in the literature investigating the effects of different doses of sugammadex on the recovery parameters of patients in reversing neuromuscular blockade in ECT procedures, the focus is generally on the effect of sugammadex used in high doses (4, 8 and 16 mg/kg)[6,7]. Considering the cost of sugammadex, doses of 2-3 mg/kg are used safely and effectively in short-term ECT procedures in our clinic. Our hypothesis in this study is that both doses of sugammadex are safe in patients undergoing ECT and will not significantly affect recovery times and hemodynamic measurements. Determining the safety and effectiveness profile of low sugammadex doses in ECT procedures is essential in reducing costs and will contribute to the literature. This retrospective observational study investigated the effect of two doses of sugammadex (2 mg/kg and 3 mg/kg) on patients' recovery and hemodynamic measurements in reversing neuromuscular blockade in ECT procedures performed in a tertiary center.

MATERIALS and METHODS

This retrospective observational study was initiated after the approval of the University of Health Sciences Turkey, Kanuni Sultan Suleyman Training and Research Hospital Clinical Research Ethics Committee (decision no: 147, date: 29.11.2023). The principles of the Declaration of Helsinki were used to conduct this study. The data of patients who underwent ECT between December 2018 and February 2020 at the University of Health Sciences Turkey, Istanbul Kanuni Sultan Suleyman Training and Research Hospital were retrospectively evaluated using the hospital information system and patient files. In our hospital, sugammadex is frequently used at doses of 2 mg/kg and 3 mg/kg to eliminate neuromuscular blockade after ECT procedures. Patients were classified as 2 mg/kg sugammadex applied group (group 2) and 3 mg/kg sugammadex applied group (group 3).

The inclusion criteria were as follows: (1) age ≥18 years; (2) rocuronium at a dose of 0.4 mg/kg and sugammadex at a dose of 2-3 mg/kg were administered for neuromuscular blockade and reversal. Exclusion criteria includedthe following: (1) absence of data; (2) cardiovascular and neuromuscular system disease; (3) liver and kidney dysfunction or failure; (4) pregnancy; (5) obesity [body mass index (BMI) >35 kg/m^2]; and (6) severe hemodynamic and respiratory problems that may require the use of medication during or after the procedure.

All patients during the 15-month period the study was conducted were evaluated, and all patients who met the study criteria were included. Patients' age, gender, BMI, hemodynamic measurements [blood pressure, heart rate, and peripheral oxygen saturation (SpO_2) before and after initial sugammadex application], diagnoses, seizure duration during ECT, time to spontaneous respiration after sugammadex application, eye-opening time, and time to comply with commands were recorded. Prospectively recorded data were analyzed retrospectively.

Anesthetic Management

Before the ECT procedure, all patients were evaluated by the anesthesiology and reanimation clinic. ECT was performed three times a week, one day apart, for patients who were planned to undergo ECT by the psychiatry department and were suitable for anesthesia. The patients underwent routine electrocardiography, non-invasive blood pressure, and SpO_2 monitoring in a

fully equipped operating room. Fluid resuscitation was initiated with isolyte solution for patients who received intravenous access with a 20-22-gauge catheter. Patients were preoxygenate with 100% oxygen for 2 min. For anesthesia induction, 1 mg/kg propofol (propofol-PF 1%, Polifarma, Turkey) was infused over 5 s. Patients administered 0.4 mg/kg rocuronium (Muscuron, Kocak Pharma, Turkey) as a neuromuscular blocker were ventilated with a balloon mask for 2 min. ECT was initiated in patients with a mouthguard placed to prevent tongue-tooth damage. After the procedure, 2 or 3 mg/kg sugammadex (Bridion, Merck Sharp Pharma, Turkey), which is frequently used in our clinic, was used to eliminate neuromuscular blockade. Some patients were excluded from the study because 0.6 mg/kg rocuronium and 4 mg/kg sugammadex were used as neuromuscular blockade and antagonists, respectively. The sugammadex dose used in the patients was determined according to the decision of the anesthesiologist in charge, and no randomization or method was applied. All patients were monitored for 30 min in the recovery room after ECT.

In anesthesia practices, the use of follow-up criteria is essential for the early diagnosis and treatment of complications in the postoperative period. The Modified Aldrete score (MAS) is widely used to transfer patients from the postanesthetic care unit to the inpatient service[8]. MAS is a scoring system in which the patient's muscle activity, respiration, circulatory system, level of consciousness, and SpO_2 are each evaluated using two points. Patients can leave the postanesthetic care unit when their MAS total score is nine or above (Table 1). A MAS score of 9 indicates that the patient's vital signs are stable and can be transferred from the recovery room to the inpatient service. The times during which the patients reached the MAS 9 value were recorded and analyzed.

ECT Procedure

The ECT team psychiatrist and anesthesiologist evaluated patients to determine suitability for ECT. ECT was administered using a bidirectional, constant-current, brief-pulse form Thymatron System IV device with bitemporal (BIL) electrode placement. ECT stimulus dosing was initially performed using an age-based method and seizure threshold titration (i.e., 1.5 X threshold for BIL ECT). If the seizure duration was ≤20 seconds, the stimulus was increased at a higher intensity.

The primary outcome of this study was to analyze the effect of two doses of sugammadex used in reversing neuromuscular blockade on spontaneous breathing and recovery of consciousness in patients undergoing ECT. The G*Power 3.1 program was used to calculate the sample size. It was calculated that 140 sessions of ECT were needed to obtain 90% power for t-tests with $p<0.05$ and an effect size of 0.5. All ECT procedures between the study dates were included in the study.

Statistical Analysis

SPSS Inc., Chicago, USA (SPSS v29.0) program was used to analyze the data. The suitability of the variables to normal distribution was evaluated analytically

Table 1. The Modified Aldrete score (adapted from reference 8).

Assesment items		**Score**
Activity	4 extremities	2
	2 extremities	1
	No movement	0
	Ability to breathe deeply, cough comfortably	2
Respiration	Dyspnea, shallow breathing	1
	Apneic	0
	Blood pressure ±20% of preanesthetic period	2
Circulation	Blood pressure ±21-49% of preanesthetic period	1
	Blood pressure ±50% of preanesthetic period	0
	Fully awake	2
Consciousness	Wakes up when called	1
	No answer	0
	>92% on room air	2
SpO_2	Oxygen inhalation required for 90% SpO_2	1
	<90% with O_2 support	0

SpO_2: Peripheral oxygen saturation

(Shapiro-Wilks test) and visually (histogram). According to the data distribution, descriptive statistics are expressed as the number of patients, percentage, mean and standard deviation, median, and range. In analyzing quantitative variables between two independent groups, the independent sample t-test was used for normally distributed data, and the Mann-Whitney U test was used for non-normally distributed data. The Pearson chi-square test and Fisher Exact test were used to evaluate qualitative data. Repeated measures ANOVA with Bonferroni correction was used to compare hemodynamic measurements between groups. The statistical significance level was set at $p<0.05$.

RESULTS

A total of 328 ECT sessions were performed on 46 patients between the relevant dates. Cases with bronchospasm (n=1), allergic reactions (n=1) requiring drug administration, and cases in which different doses of rocuronium (0.6 mg/kg, n=8) and sugammadex (4 mg/kg, n=4) were used were excluded from the study (Figure 1). most patients (65.2%, n=30) were between the ages of 25 and 44 years, and the mean age was 38.3±12.6 (range, 21-67) years, while 56.6% (n=26) were male. The average number of ECTs was 6.8±2.8 (1-15), and 60.9% (n=28) of the patients received ECT between 6 and 10 sessions (Table 2).

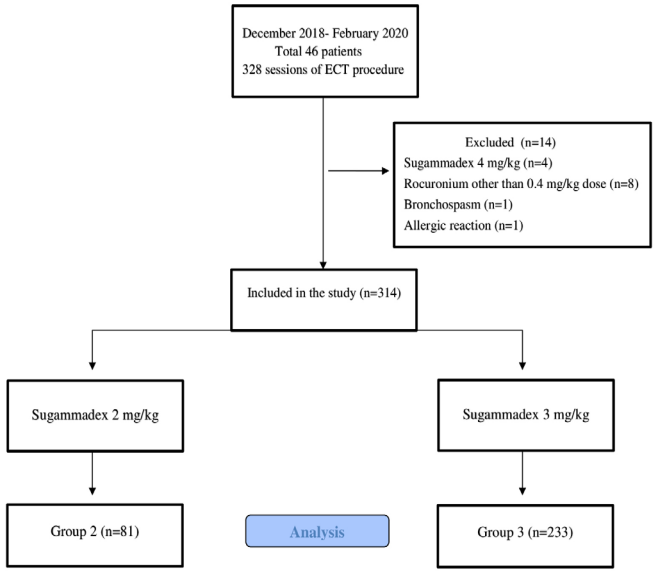

Figure 1. Flow chart of the study.

ECT: Electroconvulsive therapy

ECT was most frequently applied to patients with diagnoses of bipolar disorder (32.7%, n=18), major depression, depressive disorders (29.1%, n=16), and psychosis, schizophrenia, and schizoaffective disorder (27.2%, n=15) (Table 3).

While the average seizure duration during ECT was 28.2±12.7 seconds, there was no significant difference between the groups (29.8±14.2 vs. 27.6±12.2 seconds, p=0.344). The average time to recovery of spontaneous breathing was significantly shorter in group 3 (281±39 s vs. 308±26 s, $p<0.001$). Similarly, mean eye-opening time (301±36 s vs. 331±23 s), mean time to comply with voluntary commands (327±36 s vs. 360±20 s), and mean time to reach MAS 9 (454±33 vs. 466±36) was found

Table 2. Demographic data of patients and some clinical features.

	ECT patients (n=46)
Age (years)	38.3±12.6 (21-67)
Age range, n (%)	
18-24	4 (8.7)
25-44	30 (65.2)
45-64	10 (21.7)
≥65	2 (4.3)
Gender, n (%)	
Female	20 (43.4)
Male	26 (56.6)
BMI (kg/m²)	24.9±2.5 (23.1-26.9)
Average number of ECTs	6.8±2.8 (1-15)
ECT session, n (%)	
1-5	13 (28.3)
6-10	28 (60.9)
≥11	5 (10.9)

Data are expressed as number of patients (n), percentage, mean ± standard deviation, and range. BMI: Body mass index, ECT: Electroconvulsive therapy

Table 3. Diagnoses of patients who underwent ECT.

	ECT patients (n=46)	
	n	**%**
Bipolar disorder	18	32.7
Major depression, depressive episodes and disorders	16	29.1
Psychosis, schizophrenia and schizoaffective disorder	15	27.2
Anxiety and mixed anxiety disorders	6	10.9

ECT: Electroconvulsive therapy

to be significantly shorter in group 3 (p<0.001, p<0.001 and p=0.002, respectively) (Table 4).

No significant difference was detected between the groups in hemodynamic measurements at baseline, before the termination of the neuromuscular blockade with sugammadex, and after the application of sugammadex (p>0.05) (Table 5).

Although a mouthguard was placed in the mouth during ECT procedures to prevent tongue-tooth damage, a tooth fracture was observed in 1 case (0.3%) and a superficial cut on the tongue was observed in two cases (0.6%). Bradycardia (45-60 bpm), which did not require medication and disappeared in a short time, was detected in 2 patients (2.4%) in group 2 and 4 patients (1.7%) in group 3.

DISCUSSION

In this study, where the effects of different sugammadex doses on recovery in ECT procedures in a tertiary center were investigated, we found that 3 mg/kg sugammadex, used to reverse the neuromuscular blockade provided by rocuronium (0.4 mg/kg), significantly shortened the recovery times compared with the 2 mg/kg dose. In addition, although no difference was detected in terms of hemodynamic changes, it was observed that both doses could be used effectively and safely in ECT procedures.

Table 4. Anesthetic recovery parameters by groups.

	Group 2 (n=81)	Group 3 (n=233)	p-value
Motor seizure duration (sec)			0.344
Mean ± SD	29.8±14.2	27.6±12.2	
Median (Q1-Q3)	26 (19-40)	25 (18-35)	
Spontaneous breathing time (sec)			**<0.001**
Mean ± SD	308.9±26.6	281.6±39.2	
Median (Q1-Q3)	316 (288-326)	288 (244-317)	
Eye opening time (sec)			**<0.001**
Mean ± SD	331.9±23.5	301.7±36.6	
Median (Q1-Q3)	340 (320-350)	303 (265-334)	
Time to obey commands (sec)			**<0.001**
Mean ± SD	360.4±20.4	327.1±36.3	
Median Q1-Q3)	365 (348-374)	336 (298-349)	
Time to reach MAS 9 (sec)			**0.002**
Mean ± SD	466.9±36.1	454.4±33.4	
Median (Q1-Q3)	480 (425-490)	470 (420-480)	

MAS: Modified Aldrete score, SD: Standard deviation

Table 5. Hemodynamic measurements of groups.

	Baseline	Before the sugammadex	After the sugammadex	p-value
MBP (mmHg)				0.358
Group 2	91±10	101±10	89±10	
Group 3	91±9	103±9	92±10	
HR (bpm)				0.350
Group 2	88±12	108±14	89±13	
Group 3	87±12	108±13	90±13	
SpO_2				0.831
Group 2	99±1	98±1	99±1	
Group 3	99±1	98±1	99±1	

MBP: Mean blood pressure, HR: Heart rate, SpO_2: Peripheral oxygen saturation

There is no specified age range for ECT applications. It can be applied to children, adolescents, and elderly patients. It has been reported that it can be applied in all pregnancy and postpartum periods and should even be the first choice[9,10]. Canbek et al.[11] reported that 61% of the patients who underwent ECT were male, the average age was 34.8±11.2 years, and the average number of ECT sessions was 7.8±2.8. In another study, it was stated that 44% of the patients who received ECT were female, and the most common ECT application diagnoses were bipolar disorder (30.3%) and schizophrenia (29.5%)[12]. In our study, consistent with the literature, 56.6% of the patients who received ECT were male, and the average age was 38.3±12 years. Similarly, the most common ECT application diagnosis was bipolar disorder (32.7%), and the average number of ECTs applied to patients was 6.8±2.8.

It is essential that the anesthetic drugs used in ECT applications have a short duration of action, do not affect seizure activity and duration, provide rapid recovery, and have minimal impact on hemodynamic parameters. Because the choice of hypnotic drugs used in anesthesia induction can also affect the success of ECT, cooperation between the anesthesiology and psychiatry teams is essential for the success of the procedure. Inhalation anesthetics such as sevoflurane can be used in anesthesia induction in ECT procedures, as well as intravenous anesthetics such as methohexital, thiopental, etomidate, propofol, and ketamine[13,14]. Although methohexital is a short-acting barbiturate specified as the gold standard for the induction of ECT, it is not available in Turkey[15]. Propofol is frequently used in ECT practice because it provides rapid recovery and can effectively suppress hypertensive and tachycardic responses[16]. However, propofol has a more substantial anticonvulsant effect than other intravenous anesthetics. It has been stated that the seizure duration following the administration of high doses of propofol (1-1.5 mg/kg) is significantly shorter than that caused by methohexital, thiopental, and etomidate[7,14,16]. The literature has reported that although propofol is generally used at 1 mg/kg in ECT procedures, it is also administered at 2 mg/kg[6,17-19]. In ECT procedures in our clinic, propofol is used at a dose of 1 mg/kg, in line with the literature, and no problems have been experienced regarding seizure quality and duration.

Rocuronium is a non-depolarizing neuromuscular blocker with a steroid structure and medium effect duration that is frequently used in ECT applications. ECT is a short-term procedure. The rocuronium-sugammadex combination has become popular in ECT applications because of reasons such as the inability of cholinesterase inhibitors used to reverse the effects of nondepolarizing neuromuscular blockers to sufficiently reverse the deep block, the risk of residual paralysis, and the fact that sugammadex creates a stable cardiovascular response. However, the high cost of sugammadex limits its use. The effects of succinylcholine and rocuronium, which are used as neuromuscular blockers in ECT procedures, on recovery have been investigated. Kadoi et al.[7] investigated the effects of succinylcholine (1 mg/kg) and rocuronium (0.6 mg/kg)-sugammadex (4, 8, or 16 mg/kg) combination on recovery and reported that the combination of 0.6 mg/kg rocuronium and 8 mg/kg sugammadex provided neuromuscular recovery equal to that of succinylcholine alone. The authors also stated that when sugammadex was used at a dose of 16 mg/kg, the time to first spontaneous breathing was significantly shortened compared with succinylcholine.

Köksal et al.[18] stated that the combination of rocuronium (0.6 mg/kg) and sugammadex (4 mg/kg) in ECT procedures provides faster recovery from the neuromuscular block than succinylcholine (1 mg/kg), and that 4 mg/kg sugammadex will be sufficient to reverse the rocuronium block and may reduce the cost. Another study reported that 0.3 mg/kg rocuronium was used in ECT procedures, and reversal of the block with 4 mg/kg sugammadex significantly shortened spontaneous breathing and eye-opening time compared with 1 mg/kg succinylcholine[19]. Some studies have emphasized that rocuronium can be used in doses of 0.3-0.4 mg/kg, stating that the ECT procedure takes a short time and partial neuromuscular blockade is sufficient[3,19]. Batistaki et al.[20] reported that combining rocuronium at 0.4 mg/kg and sugammadex at 2 mg/kg may be a suitable alternative to succinylcholine in ECT procedures. The therapeutic dose range of sugammadex is between 2 and 4 mg/kg, and considering the cost, doses of 4 mg/kg are costly. Therefore, 2-3 mg/kg doses in our clinic are frequently used to reverse the partial neuromuscular blockade provided by 0.4 mg/kg rocuronium in short-term procedures such as ECT. Our study found that sugammadex was used at a dose of 3 mg/kg in most patients who underwent ECT (233/314, 74.2%). In this group, adequate spontaneous breathing, eye-opening, obeying orders, and reaching MAS 9 were significantly shorter than 2 mg/kg. However, no significant difference was detected in the hemodynamic measurements before and after sugammadex application. Partial neuromuscular blockade (0.4 mg/kg) and low doses of sugammadex (2-3 mg/kg) can be used cost-effectively in ECT procedures.

In a practical ECT procedure, the cooperation of the anesthesiologist and psychiatrist is essential, as ideally, the aim is for patients to have seizures between 30 and 60 s[21]. It has been reported that the time between the administration of the hypnotic agent used in anesthesia induction and the beginning of the ECT stimulus is essential for the duration and quality of the seizure[22]. Prolonging this period may allow better-quality seizures because of the decrease in the level of anesthesia. However, it may also increase the risk of awareness among patients. It has been suggested that Bispectral index (BIS) monitoring can be used to optimally time the delivery of the ECT stimulus after anesthesia induction and that seizure induction should be started with a BIS value of at least 65[7]. However, BIS monitoring could be more practical for clinical practice because of cost and reliability issues. Turkkal et al.[3] reported that the duration of motor seizures was longer in ECT cases in which rocuronium was used than in those in which succinylcholine was used. They stated that lower propofol serum levels may cause this situation because of the later application of ECT in patients given rocuronium. Similarly, Hoshi et al.[23] reported that seizure duration was longer in ECT cases where the rocuronium-sugammadex combination was used than in those in which succinylcholine was used. The authors stated that factors related to patients may be influential in the emergence of this situation. In our study, propofol (1 mg/kg) was administered for 5 s or more in both groups, and no difference was observed between seizure durations. The decrease in propofol serum levels due to waiting 2 min for neuromuscular blockade may have caused this situation.

Hemodynamic changes such as arrhythmia and hypertension may occur due to electrical stimulation during ECT. During and after the procedure, damage to the tongue and teeth, myalgia, headache, and memory-related problems may occur. It has been reported that headaches and myalgia generally occur due to scalp muscle contraction and fasciculations due to electrical stimulation and succinylcholine use. In contrast, the frequency of myalgia and headache is lower in the rocuronium-sugammadex combination[19]. Another complication specific to ECT is postictal agitation. Postictal agitation is characterized by motor restlessness, disorientation, and panic-like behavior. The etiology of agitation is mostly idiopathic. However, it has been stated that it may be related to the use of lithium, the dose and selection of muscle relaxants and hypnotic agents, the presence of anxiety before the procedure, and the secondary increase in plasma lactate level secondary to inadequate neuromuscular blockade[24]. It has been stated that using succinylcholine in low doses may increase the plasma lactate level because of insufficient muscle relaxation. When rocuronium-sugammadex is used, it may cause less postictal agitation because there is less increase in plasma lactate levels. In our study, consistent with the literature, tachycardic and hypertensive responses were observed in patients during ECT. There was no significant difference between baseline and hemodynamic measurements before and after sugammadex administration. In 314 sessions of ECT, a tooth fracture was detected in 1 patient, and a superficial cut on the tongue was detected in 2 patients. Because the records of the patients during their follow-up in the recovery unit after the ECT procedure were available, headache, myalgia, and postictal agitation were not evaluated.

This study has some limitations. The first is a retrospective, single-center study. Second, neuromuscular monitoring and anesthesia depth level were not monitored with objective methods such as train of four and BIS during the ECT procedure. Third, complications such as headache, myalgia, and postictal agitation that may occur after the ECT procedure were not evaluated.

CONCLUSION

In conclusion, the rocuronium-sugammadex combination has become popular in short-term procedures that require neuromuscular blockade, such as ECT. Although the literature reports that high doses of sugammadex used in patients undergoing ECT effectively and quickly reverse neuromuscular blockade, cost is an essential factor limiting its use. This study found that 2 and 3 mg/kg sugammadex, which we can describe as low doses, are safe and cost-effective in ECT applications in reversing the neuromuscular blockade provided by 0.4 mg/kg rocuronium. In addition, in patients who underwent ECT, it was determined that the 3 mg/kg dose of sugammadex significantly shortened the recovery times, such as returning spontaneous breathing and obeying commands, compared with the 2 mg/kg dose, and had no effect on hemodynamic measurements.

Ethics

Ethics Committee Approval: This retrospective observational study was initiated after the approval of the University of Health Sciences Turkey, Kanuni Sultan Suleyman Training and Research Hospital Clinical Research Ethics Committee (decision no: 147, date: 29.11.2023).

Informed Consent: Retrospective study.

Author Contributions

Concept: K.A., A.S.S., Design: K.A., G.K., H.C.A., A.S.S., Data Collection and/or Processing: K.A., G.K., H.C.A., Analysis and/or Interpretation: K.A., H.C.A., E.A., A.S.S., Literature Search: K.A., G.K., H.C.A., E.A., Writing: K.A., E.A.

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