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Review Article

Comparison of Rocuronium-Sugammadex and Succinylcholine during Electroconvulsive Therapy: A Small Observational Case Series Study

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Abstract

Introduction: The use of neuromuscular relaxants is needed in electroconvulsive therapy (ECT) to minimize the convulsive motor activity. Succinylcholine is the most useful and commonly available neuromuscular relaxant agent for ECT. However, rocuronium with subsequent use of sugammadex was proposed for ECT as an alternative to succinylcholine.

Methods: A small case series of four patients with major depressive disorder recruited as part of a preliminary study is presented. The purpose of this study was to investigate the effect of a small dose succinylcholine (0.5 mg/kg) and rocuronium (0.3 mg/kg)-sugammadex (4 mg/kg) complex on clinical recovery during ECT as well as ECT quality and the incidence of side effects.

Results: Forty-eight ECT sessions were conducted in total in the post anesthesia care unit. The mean extent of motor seizure modification score was significantly higher in the group rocuronium-sugammadex (p=0.003). The mean time to resume spontaneous respiration and time to eye opening to verbal command were shorter following rocuronium blockade with 4 mg/kg of sugammadex compared with succinylcholine (p=0.011 and p=0.028 respectively). Agitation and myalgia were significantly lower in rocuronium-sugammadex group (p=0.043 and p=0.01 respectively).

Conclusion: This small case series study demonstrates the efficacy of rocuronium (0.3 mg/kg)–sugammadex (4 mg/kg) as an alternative to succinylcholine (0.5 mg/kg).

Keywords: Electroconvulsive Therapy; Rocuronium; Sugammadex; Succinylcholine; Motor Seizure Modification; Myalgia; Agitation

Introduction

Electroconvulsive therapy (ECT) is a therapeutic method used for almost sixty years in the treatment of mental illnesses. It is based on the generation of a generalized seizure by means of an electric current applied bytranscranial route. The goal is to obtain a clonic phase of several tens of seconds [1]. Despite an often negative image, ECT remains a highly effective treatment for major depression [2], particularly in cases of treatment-resistance, poor tolerance to psychotropic drugs, or when short-term vital risk is engaged. The renewed interest in this therapy is linked to the technical progress made concerning anesthesia and neuromuscular blockade along with a best definition of stimulation parameters.

Succinylcholine is considered the neuromuscular blocking agent of choice for ECT due to its rapid onset and short duration of action. However, succinylcholine has many side effects and its use is limited in certain situations (metabolic, neuromuscular, or neurologic comorbidities, pseudocholinesterase deficiency..). Sugammadex, a selective relaxant-binding agent allowing a rapid reverse of neuromuscular block, has been introduced as an alternative for succinylcholine during ECT [3,4].

To date, only three studies have investigated the benefit of using rocuronium–sugammadex as an alternative to succinylcholine for muscle relaxation during ECT with different described protocols [5]. The purpose of this study was to add to the body of literature by demonstrating the efficacy of rocuronium–sugammadex as an alternative to succinylcholine during ECT with a new protocol and examine ECT quality and outcome.

Materials and Methods

In this single site case series, we review prospectively collected data on ECT use in four patients who were diagnosed with major depressive disorder. Forty-eight ECT sessions were conducted in total in the post anesthesia care unit at Military Teaching Hospital in Rabat, Morocco.

Study subjects were all ASA physical status I aged 28 to 45 years. None of the patients had a history of cardiovascular disease, neuromuscular disorders, hypertension, and history of drug allergy, significant renal or liver dysfunction or electrolyte abnormalities. All patients were right handed and were taking psychotropic medications as indicated by their psychiatric condition.

Informed consent was obtained from all patients. All protocols were approved by the local institutional clinical study committee and

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the institutional review board. Each patient underwent 12 sessions of ECT (three times per week). Patients were unpremedicated and fasted overnight and ECT was performed the next morning.

Patients received preoxygenation and measured parameters during ECT included systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), oxygen saturation (SpO_2), end-tidal CO_2 ($ETCO_2$) at the nostrils and electrocardiogram.

Anesthesia was induced using propofol 1-1.5 mg/kg IV to obtain unconsciousness and loss of eyelash reflex. Two patients received 0.5 mg/kg of succinylcholine (group S) and the two others were given 0.3 mg/kg of rocuronium by intravenous route (group R).

Assisted mask ventilation was initiated with 100% oxygen to maintain an $ETCO_2$ of 30 to 35 mm Hg and a minimum SpO_2 of 97%. Esmolol (40–80 mg IV) was administered to treat hypertension and tachycardia, when necessary. ECT was given via bitemporally placed electrodes at the end of the muscle fasciculation's in group S and 90 seconds after administration of the muscle relaxant in group R.A Thymatron® System IV ((Somatics LLC, Lake Bluff, IL, USA) was used in accordance with the manufacturer's instructionsThe stimulus intensity of ECT was adjusted accordingly by an energy percentage based on the patients' ages and was increased appropriately at each session to achieve a minimum seizure duration of 20 seconds. Reversal of the residual neuromuscular block in Group R was accomplished with sugammadex 4mg/kg IV immediately after completion of the ECT procedure.

EEG seizure duration using the digital counter in the ECT machine, extent of motor seizure modification on five-point scale (A score < 3 or more on the scale were defined as poor and good modifications respectively), the time to spontaneous breathing from the moment of administration of the muscle relaxants and the time to eye opening to verbal stimuli were recorded in both groups. Patients were also assessed for the presence of agitation, myalgia, headache and nausea and vomiting post-ECT.

Data are reported as mean with standard deviation, number and percentage, depending on underlying distribution. $P < 0.05$ was considered statistically significant. Data analysis was performed using SPSS 25.0 software package for Windows (SPSS, Chicago, IL).

Results

Demographic characteristics of the patients are shown in (Table 1).

There were no statistically significant differences between the groups either in baseline values of HR, SBP, DBP, SpO_2 and mean propofol dose used (Table 2).

ECT stimulus did not differ between the groups. In both groups, duration of seizures was in clinically effective ranges and was comparable between the two groups. The mean extent of motor seizure modification score was significantly higher in the group R (p=0.003).

The mean time to resume spontaneous respiration and time to eye opening to verbal command were shorter following rocuronium blockade with 4 mg/kg of sugammadex compared with succinylcholine (Table 3). Agitation and myalgia were significantly lower in group R (Table 4).

Table 1: Demographic Data of Patients.

Patient	Sex	Age	Height (cm)	Weight (kg)
1	F	28	162	60
2	M	32	170	65
3	F	35	168	58
4	F	45	170	62

Table 2: Hemodynamic Variables and propofol dose in the study groups before ECT.

	Group S (n=24)	Group R (n=24)
HR (bpm)	82±16	80±8
SBP (mmHg)	126±10	124±16
DBP (mmHg)	78±11	80±10
SpO_2 (%)	99±1	98±1
Propofol dose (mg)	99±17	95±13

HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; SpO^2, saturation of oxygen.

Table 3: Measures of ECT stimulus dose, EEG seizure duration, motor seizure modification and clinical recovery parameters in the study groups.

	Group S (n=24)	Group R (n=24)	Significance (P value)
ECT stimulus dose (mC)	133.6±42.3	139±55.6	0.706
Duration of seizure (s)	38±2	40±7	0.184
Extent of motor seizure modification on five-point scale	3±0.5	3.6±0.8	0.003*
Time for respiratory recovery (s)	296±90	219±65	0.011*
time to eyeopening to verbal stimuli (s)	467±114	402±83	0.028*

*Significant at P <0.05

Table 4: Post-ECT outcomes.

	Group S (n=24)	Group R (n=24)	P value
Agitation	4/16%	0/0%	0.043*
Myalgia	8/33%	1/4%	0.010*
Headache	5/20%	1/4%	0.084
Nausea and vomiting	3/12%	0/0%	0.076

*Significant at P <0.05

Discussion

The use of neuromuscular relaxants is needed in ECT to minimize the convulsive motor activity, in order to prevent bone fractures and physical injuries during seizures. Although succinylcholine causes a variety of adverse effects, it is the most useful and commonly available neuromuscular relaxant agent, because of its short duration of action and rapid recovery. Rocuronium, also a relatively short-acting nondepolarizing neuromuscular agent, has been used as an alternative to succinylcholine during ECT. In a crossover study comparing 13 patients, Rocuronium 0.3 mg/kg was more suitable for ECT compared to succinylcholine 1 mg/kg although the time to the first spontaneous breathing was longer [5].

Sugammadex, a fast acting selective relaxant-binding agent that rapidly reverse rocuronium-induced neuromuscular blockade, has been used successfully for rocuronium reversal after ECT with lower rates of myalgia and headache, as well as faster awakening time

compared to succinylcholine [3,5].

Hoshi et al. first described the usefulness of the association rocuronium (0.6 mg/kg) -sugammadex (16 mg/kg) as an alternative to succinylcholine (1mg/kg) [4]. Subsequently, Kadoi et al. compared the recovery times from rocuronium 0.6 mg/kg after reversal with three different doses of sugammadex with recovery from succinylcholine 1 mg/kg [3]. Saricicek et al. compared the anesthetic recovery times and investigated the effect of succinylcholine 1 mg/kg and rocuronium 0.3 mg/kg- sugammadex 4 mg/kg on the incidence and severity of headaches and myalgia after ECT [5]. Patients recovered faster from the neuromuscular blockade with the association rocuronium-sugammadex, and myalgia and headaches were reduced after ECT.

The ECT guidelines of the Royal college of Psychiatrists recommend 0.5 – 1.5 mg/kg succinylcholine for ECT modification [7]. In our study, we aimed to compare the recommended dose of 0.5 mg/kg succinylcholine to rocuronium 0.3 mg/kg- sugammadex 4 mg/kg. Rocuronium 0.3 mg/kg provided suitable conditions for ECT compared with succinylcholine, and clinical recovery from neuromuscular blockade was faster with 4 mg/kg of sugammadex. In addition, the use of succinylcholine was significantly associated with the development of myalgia and agitation after ECT. Saricicek et al. reported an incidence of post-ECT myalgia of 37.5% and 12.5% at 6 and 12 hours after the procedure respectively [5]. The exact cause of myalgia observed in patients treated with succinylcholine has been reported to be due to the muscle damage caused by succinylcholine-induced fasciculations [8]. In our study, poor seizure modification may explain the higher incidence of myalgia in the patients treated with succinylcholine. Post-ECT agitation occurs in 5%–12% of ECT treatments and is characterized by motor restlessness, irritability, disorientation, and panic-like behaviors [9,10]. Agitation Post-ECT may be associated with increased plasma lactate levels [11,12]. A low dose of succinylcholine, like the one used in our study, accompanied by inadequate muscle relaxationmay cause a raised plasma lactate level [12].

The limitations of this observational study were absence of neuromuscular monitoring of the patients and the limited number of patients. We conducted this case series as a preliminary study before conducting a full clinical trial. Unfortunately, the case series was rapidly terminated following objections from the psychiatrists regarding the adequacy of seizure modification in the succinylcholine group.

This study demonstrates the efficacy of rocuronium (0.3 mg/kg)–sugammadex (4 mg/kg) as an alternative to succinylcholine (0.5 mg/kg) as patients recover faster from the neuromuscular blockade with less myalgia and agitation. Low dose 0.5 mg/kg succinylcholine may not be suitable as a substitute for rocuronium-sugammadex during ECT because of poor adequacy of seizure modification.

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