Case Report

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Rapid Return of Spontaneous Respiration after General Anesthesia with Sugammadex in a Patient with Myasthenia Gravis

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Myasthenia gravis causes weakness and fatigue of the skeletal muscles, including respiratory muscles. When immobile surgical fields are needed, neuromuscular blocking agents (NMBAs) are often administered to block muscle activity, leading to an immobile surgical field and respiratory arrest. Acetylcholinesterase inhibitors are administered to reverse the muscle block, promoting spontaneous respiration for patient recovery. If immobile surgical fields are required in myasthenic patient operations, NMBAs should be administered. However, recovery from NMBAs using acetylcholinesterase inhibitors might be delayed in myasthenic patients due to their intake of medicines that already inhibit cholinesterase, resulting in a delay in spontaneous respiration. Sugammadex is a recently introduced medicine that reverses muscle blocks through a different mechanism from acetylcholinesterase inhibitors and can be administered to facilitate the return of spontaneous respiration in myasthenic patients. Our experience of the rapid return to spontaneous respiration of a myasthenic patient with Sugammadex is reported in this paper.

Key Words: Myasthenia gravis, Rocuronium, Sugammadex

INTRODUCTION

Myasthenia gravis is a chronic autoimmune disease consisting of antibodies that target the neuromuscular junction. The characteristic symptoms of myasthenia gravis are muscle fatigue and variable weakness caused by a decrease in functional acetylcholine receptors at the neuromuscular junction [1]. Myasthenia gravis can cause aspiration pneumonia (due to nasopharyngeal muscular weakness), dysphagia, dysarthria, and difficulty in expelling airway secretions.

When an operation requires an immobile surgical field, neuromuscular blocking agents (NMBAs) are administered to block muscle contractions. NMBAs block the muscles within the surgical field and those related to respiration, leading to an immobile surgical field and respiratory arrest, respectively. When the patient recovers from the NMBAs used for general anesthesia, acetylcholinesterase inhibitors are administered to reverse the effect on the blocked muscles. The administration of acetylcholinesterase inhibitors increases the relative quantity of acetylcholine, assists with the recovery of the blocked respiratory muscles, and promotes a rapid return of spontaneous respiration [2].

When the status of the neuromuscular junctions is normal,

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the anesthesiologist can determine the optimal doses of NMBAs. However, when their status is abnormal, especially in the case of myasthenia gravis, it is difficult to determine the optimal doses of NMBAs due to the variability of the actual functional numbers of acetylcholine receptors. Moreover, myasthenia gravis patients coming out of general anesthesia need more time to recover spontaneous respiration. Traditionally, the recovery from NMBAs is promoted by an acetylcholinesterase inhibitor, which impedes the function of the cholinesterase enzyme. The use of an acetylcholinesterase inhibitor increases the relative quantity of acetylcholine through competitive inhibition, promoting the recovery of spontaneous respiration.

When general anesthesia and an immobile surgical field are required for operation on myasthenic patients, NMBAs should be administered. However, as myasthenic patients already take medicines that inhibit cholinesterase, the recovery from NMBAs through the administration of further acetylcholinesterase inhibitors might be delayed, given the limited additional potential. This can lead to the delayed return of spontaneous respiration. When using an acetylcholinesterase inhibitor, the diminished number of actual functional acetylcholine receptors in myasthenic patients can result in an extremely variable recovery time to spontaneous respiration.

Sugammadex is a recently-introduced medicine that rapidly reverses the neuromuscular blocking effect of NMBAs. Its mechanism differs from that of acetylcholinesterase inhibitors. Sugammadex binds directly to NMBAs, quickly reversing the neuromuscular blocking effect of the NMBAs and facilitating spontaneous respiration [3]. Here, we report a case of a myasthenic patient scheduled for septostomy and septoplasty, who required general anesthesia and an immobile surgical field. In this case, the neuromuscular blocking effects of the NMBAs were rapidly reversed by sugammadex, leading to a rapid return of spontaneous respiration.

CASE REPORT

A 56-year-old man (American Society of Anesthesiologists physical class II, 170 cm in height, and weighing 82 kg) was admitted for a stuffy nose. He was scheduled to undergo a septostomy and septoplasty.

The medical history of the patient revealed that he had been diagnosed with myasthenia gravis and had undergone a thymectomy six years prior, with symptoms returning two years prior to his current admission. Since then, he had been admitted to the hospital periodically for treatment. His overall myasthenia gravis symptoms had remarkably diminished (his two upper/lower extremities' motor and sensory statuses were estimated as normal). However, some occasional symptoms, such as a difficulty to lift heavy objects, persisted. At the time of operation, his medications included prednisolone, a proton pump inhibitor, and fimasartan potassium trihydrate.

In the preoperative interview, we received a detailed explanation of the respiratory risks for patients with myasthenia gravis undergoing general anesthesia, as well as information about sugammadex and the possibility of postoperative ventilator care. After that, he provided informed consent.

The patient was transferred to the operating room with no specific premedication. To check his muscular relaxation status, we attached an NMT Electro Sensor (Datex-Ohmeda, Helsinki, Finland, mode TOF) at the patient's right ulnar nerve and applied an electrocardiograph, a pulse oximetry monitor, and a sphygmomanometer in the usual fashion. After three minutes of preoxygenation with 100% oxygen, propofol (1.5 mg/kg) was injected through the patient's intravenous line. After the patient lost consciousness (66 seconds after the propofol injection), we injected remifentanil (10 mL/h, 20 μg/mL) and rocuronium (a neuromuscular blocking agent) 0.6 mg/kg via the intravenous line and turned on the sevoflurane (3 vol%) vaporizer. In order to detect muscle contractions under electrical stimulation, the train-of-four (TOF) stimulation (4 stimuli at 2 Hz, 50 mA) was monitored during anesthesia and recovery. At the time when the T1 (the first response to the TOF stimulus) was zero (i.e., no muscle contraction to electrical stimulation, 1 minute 31 seconds after the rocuronium injection), we performed endotracheal intubation. The patient's muscular relaxation, blood pressure, heart rate, peripheral oxygen saturation, and temperature were recorded throughout the operation (Table 1).

During the operation, general anesthesia was maintained

Table 1. Muscular relaxation status, blood pressure, heart rate, peripheral oxygen saturation, and temperature during the operation

	Loss of consciousness	Rocuronium injection	Intubation	End of operation	Sugammadex injection	TOF ratio (T4/T1): 0.9
Time point*	66 sec	4 min 32 sec	6 min 3 sec	59 min 4 sec	59 min 10 sec	61 min 34 sec
TOF (T1)†	100	98	0	20	25	98
Pulse (number/min)‡	51	53	68	46	44	44
Blood pressure (mmHg)§	107/65	95/58	124/73	130/72	101/80	104/82
Temperature (°C)‖	36.5	36.5	36.5	36.3	36.3	36.3

*The starting point was the injection of propofol, and the endpoint was a TOF ratio of 0.9, †Rate of experimental T1 vs. control T1 (i.e., calibrated), ‡Assessed with electrocardiograph, §Assessed with NMT Electro Sensor (Datex-Ohmeda, Helsinki, Finland), ‖Assessed with thermometer.
T1 = first response to a train-of-four (TOF) stimulus. T4/T1 = train-of-four (TOF) fading ratio.

with sevoflurane 0.8-1.0 Mac (1.7-2.0 vol%) and remifentanil 0.01-0.20 μg/kg/min. After the operation ended, sugammadex 262 mg (4 mg/kg, the patient's ideal body weight was 65.5 kg) was administered to facilitate the recovery of spontaneous respiration when he started to awake from anesthesia. At that point, the TOF (T1) value was 25. When the value of the TOF increased to 0.9 (2 minutes 24 seconds after the sugammadex injection), the patient was extubated. The total duration of anesthesia was 65 minutes, and the patient was then transferred to the post-anesthesia care unit. The patient's blood pressure, peripheral oxygen saturation, and heart rate were observed for 30 minutes postoperatively, and no specific symptoms, such as difficulty with normal respiration activities, were observed in the post-anesthesia care unit. After that, the patient fully awoke and didn't appear any symptoms related with side effects of Sugammadex. He was transferred to the general ward. He was discharged 2 weeks later.

DISCUSSION

In this case, the neuromuscular blocking effect of the NMBAs was rapidly reversed by sugammadex, resulting in early extubation and a rapid return to spontaneous respiration. This case suggests that, when NMBAs need to be administered to provide an immobile surgical field for operation on myasthenic patients, sugammadex can be effectively used to facilitate the rapid return of spontaneous respiration.

Sugammadex is an NMBA antagonist and has a different mechanism from the usual acetylcholinesterase inhibitors. It binds directly to the NMBAs and reverses their neuromuscular blocking effects. Therefore, no acetylcholinesterase inhibitors (e.g., atropine or glycopyrrolate) are needed when using sugammadex. Several studies have compared the effects of sugammadex and acetylcholinesterase inhibitors. Jones et al. [4] reported that, when comparing sugammadex (4 mg/kg) and a combination of glycopyrrolate (14 μg/kg) and neostigmine (70 μg/kg) under general anesthesia (rocuronium 0.6 mg/kg), the group that used sugammadex recovered significantly faster. Lemmens et al. [5] also undertook studies to compare the effects of sugammadex and neostigmine when using vecuronium and sevoflurane under general anesthesia. They reported that the group that used sugammadex recovered significantly faster than the group that used neostigmine.

Sugammadex allows for faster recovery than neostigmine and pyridostigmine. It is therefore a particularly useful alternative for patients with myasthenia gravis. Rudzka-Nowak and Piechota [6] reported that a patient with myasthenia gravis who had undergone abdominal surgery and was administered 3 mg/kg of sugammadex intravenously completely recovered spontaneous respiration within 5 minutes. Moreover, Komasawa et al. [7] reported a study of patients with myasthenia gravis who had been given sugammadex. The patients were administered rocuronium 20 mg intravenously upon initiation of general anesthesia and, when the patients' neuromuscular status returned to the T1 level (the first response to a TOF stimulus), they were given sugammadex 200 mg intravenously, and their TOF value reverted to 100% within 30 seconds. In this case, after providing 4 mg/kg sugammadex intravenously, the TOF value re-

verted from 25% to 98% in 2 minutes 24 seconds. This result is in line with those of the two previous cases [6,7].

In conclusion, sugammadex is an effective medicine for the reversal of the neuromuscular blocking effect of NMBAs in patients with myasthenia gravis. This case demonstrates that, when NMBAs are needed to provide an immobile surgical field for operating on myasthenic patients, sugammadex can be used to rapidly reverse the neuromuscular blocking effect of NMBAs.

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