ABSTRACT

Background and Aim: The aim of this prospective randomized trial is to compare the quality of reversal of rocuronium with either sugammadex (SUG) versus 2.5 mg or 5 mg neostigmine (NEO).

Patients and Methods: A total of 110 patients with body mass index >40 underwent elective gastric sleeve surgery were enrolled in this study. Exclusion criteria included patients with co-existing muscular and cardiovascular diseases. Patients were randomly allocated to one of the following groups: group A (SUG), Group B (NEO 2.5 mg), and Group C (NEO 5 mg). General anesthesia was induced in the three groups using propofol 2.0 mg/kg of corrected body weight (CBW) and fentanyl 3 mcg/kg of CBW. Anesthesia was maintained with O₂/air/desflurane 1 minimum alveolar concentration. Remifentanil infusion started at 0.05–0.2 mcg/kg/min. Tracheal intubation was facilitated with rocuronium 1.2 mg/kg of CBW guided with PNS. When the train of four (TOF) reached zero, intubation was performed using a GlideScope. At the end of surgery, TOF ratio and posttetanic counts were recorded. SUG 2 mg/kg of CBW (Group A), NEO 2.5 mg (Group B), and NEO 5 mg (Group C) were administered according to the random envelope. The time to achieve 90% of TOF was recorded in seconds using a timer. ANOVA for repeated measurements was used for statistical analyses. \( P < 0.05 \) was considered statistically significant.

Results: There was a positive correlation (\( P < 0.05 \)) between the duration of surgery and the time to reach 90% of TOF in all the three groups. The time to reach 90% TOF was significantly shorter with Group A versus Groups B and C (\( P < 0.05 \)).

Conclusion: Although SUG proved to be faster than NEO 5 mg in attaining TOF >90%, the recovery pattern of both was similar.

Key words: Neostigmine; rocuronium; sugammadex

Introduction

In morbidly obese patients undergoing bariatric surgery (gastric sleeve), the pharmacologic profile of most anesthetic drugs is variable. It is uncertain upon what basis the dose of anesthetic drugs is calculated. Commonly, the doses of most anesthetic drugs are based on the ideal body weight (IBW) of the individual. However, such doses may be high in obese patients and result in delayed onset and peak of action due to the greater volume of distribution. Therefore, the corrected body weight (CBW) formula (CBW = IBW + 0.4 × TBW) is commonly used.¹ There are increasing trends among anesthesiologists to use rocuronium instead of suxamethonium for rapid sequence induction in obese patients. That trend became standard of care especially

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after the introduction of sugammadex (SUG). Sugammadex is considered the first specific reversal agent of neuromuscular blockade (NMB) induced by rocuronium or vecuronium with optimal safety profile. The objective of this study was to compare the effect of SUG with two dosages of neostigmine (NEO) (2.5 and 5 mg) on the quality of recovery from rocuronium based on intraoperative neuromuscular transmission monitoring (NMT).

**Patients and Methods**

After obtaining the approval by the Medical Ethics Committee (IRB No: 14/4000) and patient informed consent, 110 morbidly obese patients with body mass index (BMI) > 40 undergoing weight loss surgery (gastric sleeve) under general anesthesia (GA) were enrolled in the study. The exclusion criteria included lack of consent, patients with coexisting muscular diseases, and patients with severe cardiovascular diseases. Patients were divided into three groups: Group A SUG, 38 patients; Group B NEO 2.5 mg, 41 patients; and Group C NEO 5 mg, 31 patients. The randomization was performed by the principal investigator using previously prepared sealed envelopes and randomization table. In the operation room, the patient was connected to routine monitoring, electrocardiography, noninvasive arterial pressure, pulse oximetry, gas monitoring, body temperature, and monitoring of the NMT. GA was induced identically in the groups using propofol 2.0 mg/kg of CBW and fentanyl 3 mcg/kg of CBW. Tracheal intubation was facilitated with rocuronium 1.2 mg/kg of CBW when NMT showed zero score train of four (TOF). Tracheal intubation was performed using a GlideScope. Maintenance of anesthesia was achieved with mixture of oxygen/air/desflurane and remifentanil infusion at rate of 0.05–0.2 mcg/kg/min. The ventilation parameters were adjusted to maintain normocapnia. At the end of surgery, TOF ratio and posttetanic counts (PTCs) were recorded. SUG 2 mg/kg of CBW (Group A), NEO 2.5 mg (Group B), and NEO 5 mg (Group C) were administered. The time to achieve 90% of TOF was recorded in seconds using a timer. Thereafter, remifentanil and desflurane were discontinued followed by tracheal extubation. ANOVA for repeated measurements was used for statistical analyses. \( P < 0.05 \) was considered statistically significant.

**Results**

The mean values of the BMI for the three Groups A, B, and C were 38, 46, and 46, respectively. The mean age in years for the same groups was 26, 27, and 25, respectively. The mean values of the CBW in kg for the same groups were 88, 86, and 86, respectively. The time in seconds to reach TOF of zero in Groups A, B, and C was 87, 83, and 85, respectively. The duration of surgery for the same groups in minutes was 72, 73, and 58, respectively. The TOF count at the time of injecting the reversal agents in the three groups was 2, 1, and 1, respectively. The PTC for the three groups at the time of injecting the reversal agents was 13, 18, and 17, respectively. The time to reach TOF 90% after giving the reversal agent in seconds for the three groups was 210, 610, and 654, respectively. There was a positive correlation \( (P < 0.05) \) between the duration of surgery and the time to reach 90% of TOF in all the three groups [Figure 1]. The time to reach 90% TOF was significantly shorter with Group A versus Groups B and C \( (P < 0.05) \). The recovery profile of the three groups was similar. We reported no side effects following SUG.

**Discussion**

Although the recovery profile for the patient who received SUG and the two dosages of NEO was similar, it seems that the time to reach 90% recovery of TOF was shorter in the SUG group of patients. SUG binds tightly to steroid-based Neuromuscular blocking drugs (NMBDs) such as rocuronium which was used in our study. The dose of SUG depends on the quantity of rocuronium which in turn is reflected by the intensity of blockade. Thus, although SUG can be effective at any level of blockade, contrary to NEO, the required dose depends directly on depth of block. For example, when two twitches are visible at the adductor pollicis, the recommended dose is 2 mg/kg b.w.; if blockade is more profound, i.e., a PTC of 1–2, a 4 mg/kg b.w. is required. A TOF ratio >0.9 is attained in 2–3 min when appropriate doses are given. In our study, we were using continuous NMT monitoring which displayed TOF ratio and PTC. NMT monitoring is essential to determine the proper dose of SUG. Furthermore, the time to reach TOF 90%

![Figure 1: Correlation between duration of surgery and time in seconds to reach train of four 90%](chart.png)
after giving the reversal agent was shorter in the SUG group versus the NEO groups. Of note, the time to reach TOF 90% was longer in the group of patients who received 5 mg NEO versus 2.5 mg NEO group of patients. That can be explained by the so-called “ceiling effect” of NEO. Which mean that when acetylcholinesterase inhibition is near 100%, any increase in NEO dose will not produce an additional effect. Moreover, there is evidence that this ceiling effect is reached at or near clinically used doses of NEO.\textsuperscript{[5,6]} In our study, we have also reported a positive correlation between the duration of surgery and the time to reach TOF of 90%. That mean with longer duration of the surgery the time to attain 90% TOF became shorter. That is well known provided the dose of rocuronium given is based on the readings of TOF and PTC obtained from continuous NMT monitoring. None of our patients experienced residual postoperative neuromuscular block (RPONB); however, RPONB remains a relevant and frequent phenomenon with an incidence ranging from 4% to 50% in the postanesthesia care unit depending on the diagnostic criteria, the type of NMBD, and the administration of a reversal agent.\textsuperscript{[7,8]} The prevention of RPONB depends on the adequacy of antagonism of nondepolarizing NMBDs achieved with either NEO or SUG if rocuronium was used. In one study, it was found that NEO cannot promptly and reliably reverse nondepolarizing NMBDs at a threshold TOF count of 4.\textsuperscript{[9]} However, unlike NEO, reduced doses of SUG were found to be efficient in antagonism of rocuronium-induced threshold TOF count of 4.\textsuperscript{[10]} The limitation of our study was the lack of sample size calculation.

**Conclusion**

NMT monitoring is essential when using NMBDs during GA. SUG proved to be faster than NEO (2.5 mg or 5 mg) in attaining TOF >90%. We believe that SUG rapidly reverses rocuronium-induced NMB with better pharmacologic profile compared to NEO. Our results confirm that SUG 2.0 mg/kg CBW administered can rapidly and effectively reverse rocuronium-induced NMB. SUG was safe and well tolerated.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.

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