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Original Research Article

A Comparative Clinical Study of Sugammadex and Neostigmine in Reversal of Vecuronium-Induced Neuromuscular Blockade in Adults

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Abstract

Background: Sugammadex is a selective relaxant-binding agent that rapidly and effectively reverses neuromuscular blockade (NMB) induced by vecuronium. It reduced incidence of residual neuromuscular blockade (RNMB) is associated with improved patient safety, fewer postoperative respiratory complications.

Objectives: To evaluate the effect of Sugammadex and Neostigmine for the reversal of Vecuronium induced neuro muscular blockades and its characteristics of recovery and the incidence of any adverse events. And to assess the hemodynamic parameters.

Methods: This prospective comparative clinical study was conducted on 100 patients scheduled for elective surgery at Katihar Medical College, Katihar. Participants were randomly selected and allocated in two equal groups. The sample size was determined to be 50 patients in each group. During the preoperative assessment, the details of the study were explained to all participants. Written informed consent was obtained from patients who agreed to participate in the study.

Keywords: Sugammadex, Neuromuscular blockades, Vecuronium, Non depolarising muscle relaxant, Alderete score, Neostigmine, general anesthesia, anticholinergic agent.

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Introduction

Neuromuscular blocking agents play an important role in modern anesthetic practice by facilitating endotracheal intubation and providing optimal surgical conditions. Vecuronium bromide is an intermediate-acting non-depolarizing neuromuscular blocking agent frequently used due to its favorable cardiovascular profile and predictable duration of action.

Incomplete reversal of neuromuscular blockade remains a significant cause of postoperative complications, including hypoventilation, airway obstruction, aspiration, and delayed recovery. Traditionally, acetylcholinesterase inhibitors such as neostigmine have been employed to reverse neuromuscular blockade. Neostigmine increases acetylcholine concentration at the neuromuscular junction, thereby competitively antagonizing the effects of non-depolarizing muscle relaxants [1]. However, neostigmine is associated with muscarinic side effects, necessitating the concurrent use of anticholinergic agents.

Sugammadex is a modified γ-cyclodextrin specifically designed to encapsulate steroidal neuromuscular blocking agents such as vecuronium and rocuronium. By directly binding free vecuronium molecules, sugammadex rapidly reduces their availability at the neuromuscular junction, resulting in prompt recovery of muscle function [2]. Concentration gradient that rapidly removes the NMBA (neuro muscular blocking agent) from the neuromuscular junction, preventing binding to nicotinic receptors. Due to its low dissociation rate, sugammadex produces rapid and reliable reversal without associated muscle weakness [6]. The clinical implications of faster and more reliable neuromuscular blockade reversal are substantial. A reduced incidence of residual neuromuscular blockade (RNMB) is associated with improved patient safety, fewer postoperative respiratory complications, and potential economic benefits through shorter recovery room stays and enhanced operating room efficiency. However, the use of sugammadex is not without limitations. Its significantly higher cost compared with neostigmine may pose economic challenges, particularly in resource-constrained healthcare settings. In addition, although uncommon, serious adverse events such as hypersensitivity reactions, anaphylaxis, and potential drug interactions (e.g., with hormonal contraceptives

and anticoagulants) have been reported. Despite these concerns, sugammadex generally demonstrates a favorable safety profile, with fewer cardiovascular and muscarinic side effects than neostigmine [3].

Many studies and meta-analyses have compared sugammadex and neostigmine for reversing vecuronium-induced neuromuscular blockade. Evidence consistently shows that sugammadex provides quicker recovery, lowers the risk of residual neuromuscular blockade (RNMB), and reduces postoperative respiratory complications in the post-anesthesia care unit (PACU). However, whether these advantages lead to significant reductions in major morbidity and mortality remains uncertain. Therefore, the choice of reversal agent should be based on patient risk, surgical requirements, institutional practices, and cost considerations. In high-risk patients, the benefits of rapid and reliable reversal may justify the higher cost of sugammadex, whereas neostigmine remains an effective and economical option for low-risk patients [4].

The present study was conducted to compare the efficacy and safety of sugammadex and neostigmine for reversal of vecuronium-induced neuromuscular blockade in adult patients undergoing elective surgery in Seemanchal region of North Eastern India.

Objectives

To evaluate the effect of Sugammadex and Neostigmine for the reversal of Vecuronium induced neuro muscular blockades and its characteristics and time of recovery and the incidence of any adverse events. And to assess the hemodynamic parameters.

Material And Methods

This prospective comparative clinical study was conducted on 100 patients scheduled for elective surgery at Katihar Medical College, AlKarim University, Katihar. Participants were randomly selected and allocated in two equal groups after obtaining written informed consent from all patients. The study was conducted over a period of six months, including patient recruitment, data collection, and analysis.

Sample Size: Group A (Sugammadex group): 50 patients received sugammadex for reversal.

Group B (Neostigmine group): 50 patients received neostigmine with glycopyrrolate for reversal.

Following criteria were adopted for selecting the patients.

Inclusion Criteria

1. Patients of both sexes are classified as American Society of Anesthesiologists (ASA) physical status I and II.
2. Patients scheduled for elective surgery requiring general anesthesia and neuromuscular block with vecuronium
3. Anticipated duration of surgery less than 2 hours.
4. Patients aged between 18 and 60 years who were hemodynamically stable.
5. Patient provided informed consent.

Exclusion Criteria

1. Patient refusal to participate in the study.
2. Patients with known neurological or psychiatric disorders.
3. Patients with anticipated difficult airway
4. Patients receiving sedatives, hypnotics, antidepressants, or other drugs affecting the central nervous system.
5. Patent with severe hepatic, renal, or cardiac dysfunction.
6. Patients with known hypersensitivity or allergy to the study drugs (Neostigmine, sugammadex, vecuronium).
7. Pregnant or lactating women due to potential maternal and fetal complications.

Patients were enrolled after a thorough pre-anesthetic evaluation and necessary investigations. Based on previous studies [17], the sample size was determined to be 50 patients in each group. During the preoperative assessment, the details of the study were explained to all participants. Written informed consent was obtained from patients who agreed to participate in the study. Participants were then randomly allocated to one of the two groups using the closed-envelope technique.

Procedure and Methodology: Standard preoperative fasting guidelines were followed. Upon arrival in the operating room, routine monitoring, including electrocardiography (ECG), non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), and capnography, was instituted.

General anesthesia was induced with intravenous propofol and fentanyl. Vecuronium was administered to achieve neuromuscular blockade and facilitate endotracheal intubation. Anesthesia was maintained using isoflurane in a mixture of oxygen and nitrous oxide, with supplemental opioids administered as necessary to ensure adequate analgesia throughout the procedure. At the end of the surgical procedure, once reversal of neuromuscular blockade was deemed clinically appropriate, patients were randomized to receive either:

Group A: Patients received sugammadex 2 mg/kg intravenously upon reappearance of the second response in the train-of-four (TOF) count.

Group B: Patients received neostigmine 0.05 mg/kg combined with glycopyrrolate 0.01 mg/kg intravenously upon reappearance of the second response in the train-of-four (TOF) count.

The primary outcome was the time required to achieve a train-of-four (TOF) ratio of ≥0.9. Secondary outcomes included hemodynamic changes, adverse events (such as nausea, vomiting, bradycardia, bronchospasm, and hypersensitivity reactions), and postoperative recovery profiles.

Neuromuscular monitoring data and relevant clinical parameters were recorded throughout the intraoperative period. Following surgery, patients were observed in the post-anesthesia care unit (PACU) for a minimum of 60 minutes. During this period, monitoring focused on the detection of adverse respiratory events, hemodynamic instability, and any other postoperative complications.

The Aldrete score (often referred to as the Modified Aldrete Score) is used in the Post-Anesthesia Care Unit (PACU) to assess a patient's physiological recovery and determine if they are safe to be discharged after anesthesia. Patients Score of 9 or higher discharged from PACU.

All data were entered into Microsoft Excel and subsequently analyzed, Quantitative variables were expressed as mean ± standard deviation (SD) and compared between the two groups using the independent Student's t-test. Qualitative variables were expressed as frequencies and percentages and were analyzed using the Chi-square test and Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

A structured proforma was used to collect data on patient demographics, intraoperative variables, the reversal agent administered, time to recovery of a TOF ratio ≥ 0.9, hemodynamic parameters, and postoperative adverse events. All collected data were reviewed and verified for accuracy and completeness before statistical analysis.

Table 1: Comparison of Sugammadex and Neostigmine NMB on the basis of heart rate (beats/min)

Time	Sugammadex	Neostigmine	Mean difference	T value	P value	Significance
Baseline	80±5.8	81.1±4.6	1.1	-1.05	0.296	NS
Induction	79.6±4.8	80.3±5.1	0.7	-0.706	0.481	NS
Intubation	83.8±3.9	84.2±3.3	0.4	-0.55	0.58	NS
After administration of reversal agent						
2 min	82.6±2.9	83±3.5	0.4	-0.622	0.535	NS
5 min	80.6±2.2	80.9±4.1	0.3	-0.455	0.649	NS
After extubation						
5 min	78.9±3,1	79.2±2.4	0.3	-0.546	0.590	NS
10 min	76.7±3.4	76.9±3.6	0.2	-0.285	0.776	NS
15 min	74.2±3,1	75±2.9	0,8	-1.33	0.186	NS
20 min	72±2.2	73.2±1.9	1.2	-2.91	0.004	Sig

Table 1 show that there was no significant difference in heart rate between the two groups at most time intervals ($p > 0.05$). At 20 minute there is significant change in two groups p value is 0.004(<0.05).

Table 2: Comparison of reversal outcomes and adverse-event composite (Total No. 100)

Outcome	Group A (Sugammadex) (n=50)	Group B (Neostigmine) (n=50)	Mean Difference	Unpaired Studemt T Test
Time to TOF ratio ≥0.9, min, Mean (SD	2.5± 1.0	10.5± 3.5	Mean diff= --8min	-15.54 p=0.001
Extubation time from reversal, min, Mean (SD)	5.4± 1.6	11.7± 3.3	Mean diff= -6.3min	-12.14 p=0.001
PACU stay, min, Mean (SD)	30± 10	50± 8	Mean diff= --20min	-11.04 p=0.001

Table 2:The time required to achieve a TOF ratio ≥ 0.9 was significantly shorter in the sugammadex group (2.5 ± 1.0 minutes) than in the neostigmine group (10.5 ± 3.5 minutes), with a mean difference of 8 minutes ; $p < 0.001$).Similarly, the time to extubation following reversal was significantly shorter in patients receiving sugammadex (5.4 ± 1.6 minutes) compared with those receiving neostigmine (11.7 ± 3.3minutes), with a mean difference of −6.3 minutes; $p < 0.001$).In addition, the duration of PACU stay was significantly reduced in the sugammadex group (30.0 ± 10.0 minutes) compared with the neostigmine group (50.0 ± 8 minutes), with a mean difference of −20.0 minutes; $p < 0.001$).

Table 3: Time to recovery of neuromuscular function (TOF ≥0.9) after reversal (N = 100)

Measure	Sugammadex (n=50)	Neostigmine (n=50)	Test
Time to TOF ≥0.9, min, Mean (SD)	2.5± 1.0	10.5± 3.5	Student T-test, 5.54 p<0.001
Achieved TOF ≥0.9 within 3 min, n (%)	46(92%)	2(4%)	p=0.001
Achieved TOF ≥0.9 within 5min, n (%)	49(98%)	13(26%)	p=0.001
TOF ≥0.9 took >10 min, n (%)	1(2%)	37(74%)	p=0.001

Table 3 further demonstrates the superior efficacy of sugammadex in reversing neuromuscular blockade. The mean time to recovery of a TOF ratio ≥ 0.9 was significantly shorter in the sugammadex group (2.5 ± 1.0 minutes) than in the neostigmine group (10.5 ± 3.5 minutes; $p < 0.001$). Notably, 92% of patients who received sugammadex achieved a TOF ratio ≥ 0.9 within 3 minutes, compared with only 4% of patients in the neostigmine group ($p < 0.001$). Within 5 minutes, neuromuscular recovery was achieved in 98% of patients in the sugammadex group, whereas only 26% of patients in the neostigmine group reached the same level of recovery ($p < 0.001$). In contrast, delayed recovery (>10 minutes) was observed in only 2% of patients receiving sugammadex, compared with 74% of those receiving neostigmine (; $p < 0.001$). These findings highlight the markedly faster and more predictable reversal of neuromuscular blockade with sugammadex compared to neostigmine.

Table 4: Incidence of individual adverse events (N = 100)

Adverse event	Sugammadex (n=50)	Neostigmine (n=50)	Test
PONV (treated), n (%)	3(6%)	10(20%)	Chi square=4.332 p=0.03
Desaturation <92% (PACU), n (%)	2(4%)	9(18%)	Chi square=5.005 p=0.025
Bradycardia requiring treatment, n (%)	2(4%)	8(16)	chisquare=4.00 p=0.0455
Residual paralysis (TOF <0.9 at 15 min in PACU), n (%)	1(2%)	6(12%)	chisquare=3.84 p=0.05
Hypersensitivity reaction, n (%)	0(%)	0(0%)	Fisher's exact, p=1.00
Bronchospasm, n (%)	0(0%)	3(6%)	Fisher's exact, p=0.2433

Table 4: demonstrates a notable difference in the incidence of adverse events between the two groups. Bradycardia requiring intervention occurred in 16% of patients in the neostigmine group compared with only 4% in the sugammadex group ($p = 0.0455$). Postoperative nausea and vomiting (PONV) was also less common among patients receiving sugammadex (6%) than among those receiving neostigmine (20%), ($p = 0.03$) Hypoxemic episodes ($SpO_2 < 92\%$ in the PACU) were observed in 18% of patients in the neostigmine group, compared with only 4% in the sugammadex group ($p = 0.025$). Residual neuromuscular blockade (TOF ratio < 0.9 at 15 minutes in the PACU) was detected in 12% of patients receiving neostigmine only 2% observed in patient received sugammadex ($p = 0.05$). Bronchospasm occurred in three patients(6%) in the neostigmine group and in none of the patients in the sugammadex group; however, this difference was not statistically significant ($p = 0.2433$). Overall, the adverse-event profile favored sugammadex, which was associated with fewer clinically significant complications and a lower incidence of residual neuromuscular blockade compared with neostigmine.

Table 5: Overall recovery profile and perioperative outcomes (N = 100)

Outcome	Sugammadex (n=50)	Neostigmine (n=50)	Effect size & 95% C	Test
Time to Aldrete score ≥9, Mean (SD)	10.4±3.1(min)	19.7±4.3	Mean diff=9.3min	Student T-test=-12.40 p=0.001
Discharged from PACU ≤60 min, n (%)	43(86%)	27(54%)		Chi-square test=12.19 p=0.0004
Post-op airway support in PACU (jaw thrust/oropharyngeal airway), n (%)	1(2%)	5(10%)		Fisher's exact, p=0.2044
Re-intubation in PACU, n (%)	0(%)	(0%)		Fisher's exact, p=1.000

Table 5 demonstrates that the quality of recovery was significantly better in the sugammadex group than in the neostigmine group. The mean time required to achieve an Aldrete score ≥ 9 was significantly shorter in patients receiving sugammadex (10.4 ± 3.1 minutes) compared with those receiving neostigmine (19.7 ± 4.3 minutes), with a mean difference of −9.3 min; ($p < 0.001$). Early discharge from the PACU (within 60 minutes) was achieved in 86% of patients in the sugammadex group, compared with 54% of patients in the neostigmine group ($p = 0.0004$). Airway support interventions, including jaw thrust and oropharyngeal airway insertion, were required more frequently in the neostigmine group (10%) than in the sugammadex group (2%); however, ($p = 0.2044$). None of the patient in the neostigmine and sugammadex group required re-intubation in the PACU,. Above findings indicate a faster and higher-quality postoperative recovery among patients receiving sugammadex.

Discussion

As shown in Table 2, sugammadex provided a substantially faster and more reliable reversal of neuromuscular blockade than neostigmine. In addition, sugammadex was associated with fewer adverse events and a smoother postoperative recovery course in the PACU. The mean time to achieve a TOF ratio ≥ 0.9 was significantly shorter in the sugammadex group (2.5 ± 1.0 minutes) compared with the neostigmine group (10.5 ± 3.5 minutes). These findings are consistent with the magnitude and direction of effect reported in previous randomized controlled trials and meta-analyses, which have consistently demonstrated the superior efficacy of sugammadex in reversing neuromuscular blockade and facilitating more rapid recovery.

Similar findings have been reported by Khuenl-Brady et. al.[7] and Lemmens et.al,[8] who demonstrated that sugammadex provided a significantly faster and more effective reversal of vecuronium-induced neuromuscular blockade compared with neostigmine. Likewise, a study conducted by Tiffany Woo et. al.[10] evaluating the reversal of rocuronium-induced neuromuscular blockade found that sugammadex was considerably more effective than neostigmine in achieving rapid and reliable recovery. These findings are in agreement with the results of the present study, further supporting the superior efficacy of sugammadex over neostigmine for the reversal of neuromuscular blockade.

Similarly, Hristovska et al.[9] evaluated the efficacy and safety of sugammadex compared with neostigmine for the reversal of neuromuscular blockade (NMB) in adults. Their meta-analysis, which included 10 clinical trials, demonstrated that sugammadex (2 mg/kg) reversed moderate NMB from the reappearance of the second twitch of the train-of-four (TOF) to a TOF ratio > 0.9 in a mean time of 2.0 minutes, whereas neostigmine (0.05 mg/kg) required 12.9 minutes to achieve the same level of recovery. These findings further support the superior efficacy and faster onset of action of sugammadex compared with neostigmine for the reversal of neuromuscular blockade.

The rapid reversal achieved with sugammadex translated into significant clinical workflow benefits in the present study. Patients who received sugammadex experienced earlier extubation and shorter PACU stays compared with those who received neostigmine, with mean reductions of 6.3 minutes in extubation time and 16 minutes in PACU stay. Furthermore, a greater proportion of patients in the sugammadex group were discharged from the PACU within 60 minutes (86% vs. 54%).

Similar improvements in perioperative efficiency, including shorter time to extubation, faster PACU throughput, and reduced staffing requirements, have been reported by Motamed et al., [11] supporting the generalizability of our findings regarding postoperative recovery. Although the higher acquisition cost of sugammadex remains an important consideration, several economic analyses, including those reported by Ravindranath et al., [12] suggest that the benefits associated with reduced recovery times and lower complication rates may partially or fully offset these costs in many clinical settings.

The consistency of findings is further reflected in the categorical recovery outcomes presented in Table 3. In the present cohort, 92% of patients in the sugammadex group achieved a TOF ratio ≥ 0.9 within 3 minutes,

compared with only 4% in the neostigmine group, while only 2% of patients in the sugammadex group required more than 10 minutes to achieve recovery, compared with 74% in the neostigmine group.These proportions are consistent with published trial data and narrative reviews that highlight the predictable and rapid reversal provided by sugammadex, even in cases of deeper neuromuscular blockade. In contrast, neostigmine demonstrates greater variability in recovery, particularly when the level of blockade is moderate to deep, as described by Bologheanu R et al.[13]. Furthermore, contemporary guidelines emphasize the importance of objective quantitative neuromuscular monitoring and the use of a TOF ratio ≥ 0.9 to reduce the risk of residual paralysis. These methodological principles were incorporated into the study protocol and are reflected in the observed incidence of residual neuromuscular blockade, which was 0% in the sugammadex group compared with 12% in the neostigmine group, as also supported by Zhang Y et al.[14].

In our study safety and adverse-event patterns in Table 4 are consistent with the existing literature. We observed fewer episodes of bradycardia requiring treatment in the sugammadex group compared with the neostigmine group (4% vs. 16%), a lower incidence of treated postoperative nausea and vomiting (6% vs. 20%), and fewer desaturation events (4% vs. 18%).

Previous comparative reviews and meta-analyses have attributed these differences to the absence of muscarinic effects with sugammadex, as well as to more complete and rapid recovery of pharyngeal and respiratory muscle function following neuromuscular blockade reversal. These mechanisms have been described by Deana C et al[15]. and support the lower incidence of perioperative adverse events observed in the present study. PACU airway-support interventions and re-intubation rates were low in both groups and did not differ significantly between them. This finding is likely influenced by the relatively small sample size. However, the point estimates favored sugammadex, showing fewer airway interventions in this group, which is consistent with previously reported trends in the literature, including those described by Voss T et al. [16].

Overall, our comparative investigation into the efficacy of sugammadex and neostigmine demonstrates that sugammadex provides a faster, more predictable, and safer reversal of vecuronium induced neuromuscular blockade, irrespective of the depth of blockade.

This finding is consistent with multiple studies conducted across different populations and clinical settings, which collectively confirm the clinical advantages of sugammadex in terms of efficacy and patient safety. It also highlights the importance of optimizing neuromuscular monitoring through the routine use of quantitative techniques to ensure accurate assessment of recovery and to reduce the risk of residual neuromuscular blockade.

Conclusion

The present comparative study demonstrates that sugammadex provides a significantly faster and more reliable reversal of vecuronium induced neuromuscular blockade compared with neostigmine. Patients in the sugammadex group achieved earlier recovery to a TOF ratio ≥ 0.9, shorter extubation times, and reduced PACU stays.Furthermore, the incidence of adverse events, including bradycardia, postoperative nausea and vomiting, desaturation, and residual paralysis, was markedly lower with sugammadex, highlighting its superior safety profile. Overall, sugammadex was associated with a smoother and more predictable recovery, contributing to improved perioperative outcomes. Although cost considerations remain a limitation in resource-constrained settings, its clinical advantages support the use of sugammadex as a preferred option, particularly in high-risk patients and in situations where rapid and complete reversal of neuromuscular blockade is essential.

Limitations of the Study: This study was conducted at a single center with single blinding and included a relatively small sample size of 100 participants. Therefore, it may not fully represent the broader variability in neuromuscular blockade reversal or the full spectrum of potential adverse effects associated with the study drugs.

As a result, the limited sample size may reduce the generalizability of the findings. Further multicenter studies with larger sample sizes are warranted to evaluate these outcomes more comprehensively and to strengthen the external validity of the results.

References

1. Thilen SR, Sherpa JR, James AM, Cain KC, Treggiari MM, Bhananker SM. Management of muscle relaxation with rocuronium and reversal with neostigmine or sugammadex guided by quantitative neuromuscular monitoring. Anesthesia & Analgesia. 2024 Sep1;139(3):536-44.
2. Bom A, Bradley M, Cameron K, et al. A novel concept of selective relaxant binding agents. Angewandte Chemie International Edition. 2002;41(2):266–270.
3. Li Q, Yao H, Wu J, Xu M, Xie H, Wu D. A comparison of neuromuscular blockade and reversal using cisatricurium and neostigmine with rocuronium and sugamadex on the quality of recovery from general anaesthesia for percutaneous closure of left atria appendage. Journal of Cardiothoracic Surgery. 2022 Aug 26;17(1):211.

4. De Souza CM, Tardelli MA, Tedesco H, Garcia NN, Caparros MP, Alvarez-Gomez JA, de Oliveira IS. Efficacy and safety of sugammadex in the reversal of deep neuromuscular blockade in duced by rocuronium in patients with end-stage renal disease: a comparative prospective clinical trial. European Journal of Anaesthesiology| EJA. 2015 Oct 1;32(10):681-6.
5. Moore E, Hunter J. The new neuromuscular blocking agents: do they offer any advantages? Br J Anaesth. 2001;87(6):912–25.
6. Khuenl-Brady KS, Wattwil M, Vanacker BF, Lora-Tamayo JI, Rietbergen H and Alvarez-Gómez JA. Sugammadex provides faster reversal of vecuronium-induced neuromuscular blockade compared with neostigmine: A multicenter, randomized, controlled trial. Anesth Analg. 2010;110(1):64-73
7. Lemmens HJ, El-Orbany MI, Berry J, Morte JB Jr., and Martin G. Reversal of profound vecuronium-induced neuromuscular block under sevoflurane anesthesia: Sugammadex versus neostigmine. BMC Anesthesiol. 2010; 10:15. https://doi.org/10.1186/1471-2253-10-15
8. Hristovska AM, Duch P, Allingstrup M and Afshari A. The comparative efficacy and safety of sugammadex and neostigmine in reversing neuromuscular blockade in adults. A Cochrane systematic review with meta-analysis and trial sequential analysis. Anaesthesia. 2018;73(5):631-641.
9. Woo T, Kim KS, Shim YH, Kim MK, Yoon SM, Lim YJ, et al. Sugammadex versus neostigmine reversal of moderate rocuronium-induced neuromuscular blockade in Korean patients. Korean J Anesthesiol. 2013;65(6):501-507.
10. Motamed C, Trillat B, Fischler M, le Guen M, Bourgain JL. Reversal of neuromuscular block with neostigmine and sugammadex: a retrospective cohort study in two centers using different types of neuromuscular monitoring. Journal of Clinical Monitoring and Computing. 2025 Feb;39(1):141-8.
11. Ravindranath S, Backfish-White K, Wolfe J, Ranganath YS. Sugammadex for Neuromuscular Blockade Reversal: A Narrative Review. Journal of Clinical Medicine. 2025 Jun 11;14(12):4128.
12. Bologheanu R, Lichtenegger P, Maleczek M, Laxar D, Schaden E, Kimberger O. A retrospective study of sugammadex for reversal of neuromuscular blockade induced by rocuronium in critically ill patients in the ICU. Scientific Reports. 2022 Jan 18;12(1):897.
13. Zhang Y, Jiang Y, Lei Q, Li C, Jin SA, Wang Q, Huang Y, Li Y, Hong Y, Wang S, Lin H. Phase III clinical trial comparing the efficacy and safety of adamgammadex with sugammadex for reversal of rocuronium-induced neuromuscular block. British Journal of Anaesthesia. 2024 Jan 1;132(1):45-52.
14. Deana C, Barbariol F, D'Incà S, Pompei L, Rocca GD. SUGAMMADEX versus neostigmine after ROCURONIUM continuous infusion in patients undergoing liver transplantation. BMC anesthesiology. 2020 Mar 25;20(1):70.
15. Voss T, Wang A, DeAngelis M, Speek M, Saldien V, Hammer GB, Wrishko R, Herring WJ. Sugammadex for reversal of neuromuscular blockade in pediatric patients: Results from a phase IV randomized study. Pediatric Anesthesia. 2022 Mar;32(3):436-45.
16. B. Brueckmann, N. Sasaki, P. Grobara et.al, Effects of sugammadex on incidence of postoperative residual neuromuscular blockade: a randomized, controlled study British Journal of Anaesthesia, 115 (5): 743–51 (2015).
17. B. Brueckmann, N. Sasaki, P. Grobara et.al, Effects of sugammadex on incidence of postoperative residual neuromuscular blockade: a randomized, controlled study British Journal of Anaesthesia, 115 (5): 743–51 (2015).