

Sugammadex versus Neostigmine for Reversal of Residual Neuromuscular Block - Effect on Early Postoperative Recovery — A Prospective Randomised Study

¹Dr. Rajib Hazarika, Professor and Head, Department of Anaesthesiology and Critical Care, Bongaigaon Medical College and Hospital, Bongaigaon, Assam, India.

²Dr. Monmy Deka, Associate Professor (DACP), Department of Anaesthesiology and Critical Care, Gauhati Medical College and Hospital, Guwahati, Assam, India.

³Dr. Jutimollika Hazarika, Post Graduate Trainee, Department of Anaesthesiology and Critical Care, Gauhati Medical College and Hospital, Guwahati, Assam, India.

Corresponding Author: Dr. Jutimollika Hazarika, Department of Anaesthesiology and Critical Care, Gauhati Medical College and Hospital, Guwahati, Assam, India.

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Abstract

Reversal of neuromuscular blockade influences not only the speed of recovery but also the quality of early emergence from an anesthesia. This prospective, randomised study compared sugammadex with a combination of neostigmine and glycopyrrolate with respect to early postoperative recovery in adults undergoing elective abdominal surgery under general anesthesia with vecuronium. A total of 164 patients (American Society of Anaesthesiologists physical status I to III) were randomly allocated in equal numbers to receive sugammadex or neostigmine - glycopyrrolate for reversal at a train-of-four count of two twitches, with quantitative neuromuscular monitoring performed Throughout.

Baseline and intraoperative characteristics were comparable between the two groups. The mean time to a train-of-four ratio of 0.9 or more was 9.5 minutes with sugammadex compared with 10.2 minutes with neostigmine, and residual block at extubation was less frequent with sugammadex (12 of 82 patients) than with neostigmine (20 of 82 patients), although neither difference was statistically significant. Postoperative nausea and vomiting occurred in 18 patients receiving sugammadex compared with 25 receiving neostigmine, unplanned intensive care unit admission occurred in 3 versus 6 patients respectively, and mean hospital stay was 5.2 versus 5.8 days. Oxygen desaturation was also numerically lower with sugammadex. Patients with a train-of-four ratio below 0.9 at extubation had a higher incidence of postoperative desaturation and nausea and vomiting than those with

adequate recovery. Although none of these differences reached statistical significance, sugammadex was consistently associated with a smoother early recovery profile than neostigmine-glycopyrrolate, with fewer complications and a shorter hospital stay, suggesting a clinically relevant advantage that warrants confirmation in larger trials.

Keywords: Sugammadex, Neostigmine, Neuromuscular Blockade, Postoperative Recovery, Train-of-Four, Postoperative Nausea and Vomiting

Introduction

Adequate reversal of neuromuscular blockade is essential not only to allow safe tracheal extubation but also to ensure a smooth, complication-free early postoperative course¹.

Residual neuromuscular blockade, defined as a train-of-four (TOF) ratio below 0.9, has been linked to impaired pharyngeal function, hypoxaemia, and a higher burden of early postoperative symptoms². Sugammadex, by directly encapsulating aminosteroidal neuromuscular blocking agents, produces faster and more complete reversal than neostigmine, and lacks the muscarinic side effects associated with the latter, such as nausea and bradycardia^{3,4}.

While the effect of reversal agent choice on major pulmonary complications has been extensively studied^{5,6}, comparatively less attention has been paid to its influence on the broader early recovery experience — postoperative nausea and vomiting (PONV), oxygen desaturation, unplanned escalation of care, and length of hospital stay. These outcomes matter directly to patients and to health-service utilisation, independent of whether a patient develops frank pneumonia or atelectasis. Some evidence suggests sugammadex may reduce PONV and desaturation events owing to its distinct side-effect profile^{7,8}, but this has not been consistently confirmed.

This study aimed to compare sugammadex and neostigmine - glycopyrrolate with respect to neuromuscular recovery characteristics and early postoperative outcomes — PONV, oxygen desaturation, unplanned intensive care unit (ICU) admission, and hospital stay — in patients undergoing elective abdominal surgery, and to examine whether residual

neuromuscular blockade at extubation was itself associated with these outcomes.

Materials and Methods

This single-centre, prospective, randomised controlled study was conducted in the Department of Anaesthesiology and Critical Care of a tertiary care teaching hospital over one year, after approval by the Institutional Ethics Committee and prospective registration with the Clinical Trials Registry - India. Written informed consent was obtained from all participants.

Inclusion criteria

Adults aged 18 years and above, of ASA physical status I-III, scheduled for elective abdominal surgery under general anaesthesia, without known pre-existing pulmonary infection, were eligible.

Exclusion criteria: known neuromuscular disease, hypersensitivity to study drugs, severe hepatic/renal impairment, pre-existing pulmonary infection, pregnancy were excluded. Considering the power of the study as 87% and level of significance as 5%, calculation of sample size is done based on a Pulmonary symptom scale of 0-4. Here, 150 subjects randomized to two groups (75+75) were required with at least three observations per subject (i.e. 12hrs, 24hrs and 48hrs post operatively) to allow a minimum difference of 5%. A slightly larger sample was recruited to allow an attrition rate of 10%. Therefore, patients in each group= 82, with a total sample size of (82+82) 164 patients.

Eligible patients were randomly allocated, using computer generated block randomization, in a 1:1 ratio to receive sugammadex or neostigmine with glycopyrrolate for reversal of neuromuscular blockade. Concealment of allocation was done by sealed envelope technique.

General anaesthesia was induced with propofol and vecuronium, and neuromuscular blockade was monitored quantitatively at the adductor pollicis muscle using train-of-four stimulation of the ulnar nerve. Reversal was administered when the TOF count reached two twitches, using either intravenous sugammadex or a combination of intravenous neostigmine and glycopyrrolate according to group allocation.

TOF monitoring continued until extubation, performed once a TOF ratio of 0.9 or more was achieved.

Patients were observed after extubation for oxygen desaturation, PONV, need for tracheal re-intubation, and unplanned ICU admission. Hospital stay was recorded in days. The primary outcomes for this analysis were the incidence of PONV, oxygen desaturation, unplanned ICU admission, and hospital stay; TOF recovery parameters were analysed both as an outcome in their own right and as an explanatory variable for the other outcomes. Continuous variables are presented as mean $\pm$ standard deviation and compared using an unpaired t-test; categorical variables are presented as frequencies and compared using the chi-square or Fisher's exact test as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results and Discussion

Of 180 patients assessed for eligibility, 164 were randomised: 82 to sugammadex and 82 to neostigmine-glycopyrrolate. Baseline demographic and intraoperative variables were comparable between groups (Table 1, Table 2).

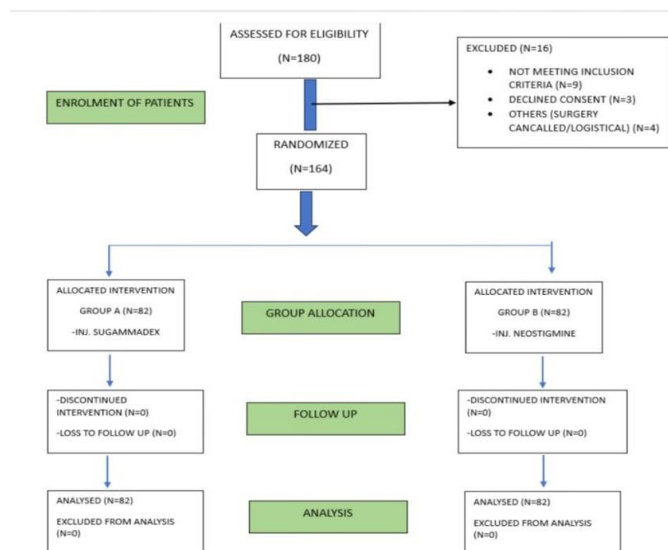


Figure 1: CONSORT Diagram

The mean time to a TOF ratio ≥ 0.9 was 9.5 minutes with sugammadex versus 10.2 minutes with neostigmine ($p > 0.05$). At extubation, TOF < 0.9 occurred in 12/82 patients with sugammadex compared with 20/82 with neostigmine (Table 3). Consistent with the established pharmacology of

sugammadex, this trend towards more reliable recovery is in keeping with prior randomised trials showing faster, more complete reversal with sugammadex compared with neostigmine^{3,9}.

PONV occurred in 18/82 patients receiving sugammadex compared with 25/82 receiving neostigmine; unplanned ICU admission occurred in 3/82 versus 6/82; oxygen desaturation was also numerically lower with sugammadex, and mean hospital stay was shorter (5.2 versus 5.8 days) (Table 4). None of these differences reached statistical significance, but the consistent direction of effect across several independent outcomes is notable. This pattern is plausible mechanistically: neostigmine's muscarinic effects are a recognised contributor to PONV⁷, and residual neuromuscular weakness has an established link to hypoxaemic events².

Our findings are broadly consistent with meta-analyses reporting lower PONV with sugammadex, although the existing literature on this specific outcome has been inconsistent^{7,8}.

On correlation analysis, patients with TOF < 0.9 at extubation had a higher incidence of postoperative oxygen desaturation and PONV than those achieving adequate recovery, supporting residual neuromuscular blockade as a contributor to early postoperative morbidity independent of which reversal agent was used^{2,6}. This suggests that the observed differences between groups may be mediated, at least in part, through differences in the reliability of neuromuscular recovery rather than a direct pharmacological effect of the reversal agent itself.

Our study should be interpreted in light of its modest sample size, which was not powered specifically for these secondary early-recovery endpoints, and its single-centre design.

Anaesthesiologists administering the reversal agent could not be blinded to group allocation, which may have introduced observer bias for subjective outcomes such as PONV, though objective measures such as oxygen saturation are less susceptible to this. Larger, adequately powered trials are needed to confirm whether the consistent favourable trend

observed here for sugammadex translates into a statistically robust reduction in early postoperative morbidity.

Conclusion

In this prospective randomised study, sugammadex was associated with more reliable neuromuscular recovery and a consistent, though not statistically significant, trend towards fewer early postoperative complications - including PONV,

oxygen desaturation, and unplanned ICU admission - and a shorter hospital stay compared with neostigmine - glycopyrrolate.

Residual neuromuscular blockade at extubation was itself associated with a higher incidence of early postoperative morbidity, reinforcing the clinical importance of reliable neuromuscular reversal regardless of the agent chosen.

Legend Tables and Figures

Table 1: Baseline demographic and clinical characteristics.

Variable	Sugammadex (n=82)	Neostigmine (n=82)	p-value
Age (years, mean $\pm$ SD)	50.5 $\pm$ 18.5	49.5 $\pm$ 17.8	>0.05
BMI (kg/m ² , mean $\pm$ SD)	24.7 $\pm$ 6.1	25.8 $\pm$ 6.9	>0.05
ASA I / II / III	30 / 32 / 20	28 / 34 / 20	>0.05

Table 2: Intraoperative variables

Variable	Sugammadex	Neostigmine	p-value
Duration of surgery/anaesthesia	Comparable	Comparable	>0.05
Total vecuronium dose	Comparable	Comparable	>0.05
TOF count at reversal	2 twitches	2 twitches	—

Table 3: Neuromuscular recovery parameters

Parameter	Sugammadex	Neostigmine	p-value
Time to TOF ≥ 0.9 (min)	9.5	10.2	>0.05
TOF <0.9 at extubation (n)	12	20	>0.05

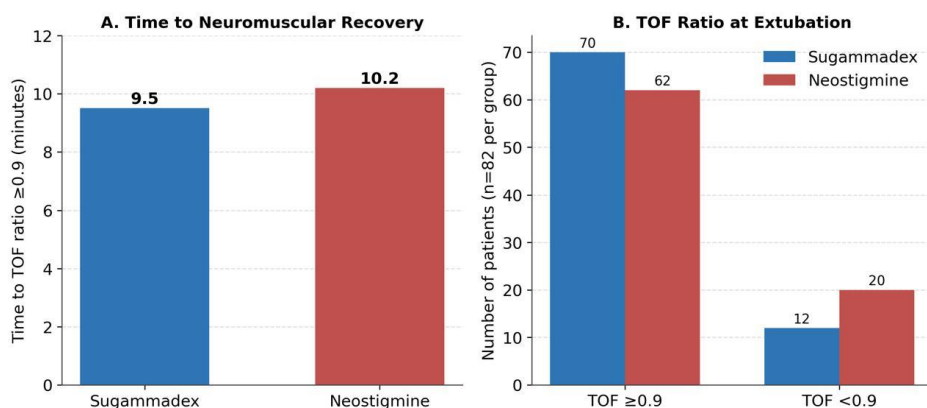


Figure 2: TOF recovery characteristics

Table 4: Early postoperative outcomes

Outcome	Sugammadex	Neostigmine	p-value
PONV (n)	18	25	>0.05
Oxygen desaturation	Lower	Higher	>0.05

Outcome	Sugammadex	Neostigmine	p-value
Unplanned ICU admission (n)	3	6	>0.05
Mean hospital stay (days)	5.2	5.8	>0.05

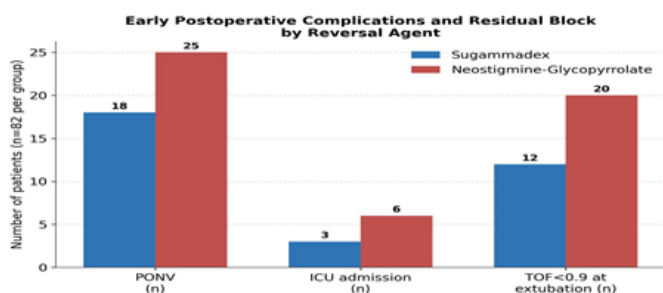


Figure 3: Postoperative outcomes

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