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CLINICAL TRIAL REPORT

Sugammadex for Neuromuscular Blockade Reversal and Postoperative Recovery in Laparoscopic Bariatric Surgery: A Randomized Controlled Trial

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Objective: The aim of this study was to evaluate the effect of sugammadex on the quality of postoperative recovery among patients undergoing laparoscopic bariatric surgery.

Methods: In this randomized controlled trial, 60 patients scheduled for laparoscopic bariatric surgery were allocated to receive either neostigmine (N group) or sugammadex (S group) for neuromuscular blockade reversal. At the conclusion of surgery, the N group received intravenous neostigmine 0.04 mg/kg with atropine 0.02 mg/kg, while the S group received intravenous sugammadex 2 mg/kg. The primary outcome was the Quality of Recovery-15 (QoR-15) score at 24 hours postoperatively. Secondary outcomes included anesthesia recovery time, time to train-of-four (TOF) ratio ≥ 0.9, extubation time, time to achieve a modified Aldrete score ≥ 9, Richmond Agitation-Sedation Scale (RASS) scores, Visual Analogue Scale (VAS) pain scores after extubation, and time to first postoperative flatus/defecation.

Results: QoR-15 scores at 24 hours postoperatively were significantly higher in the S group compared with the N group ($p < 0.001$), with the intergroup Cohen's d was 1.547 (95% CI: 1.014 to 2.293). The S group demonstrated shorter anesthesia recovery time, time to achieve TOF ratio ≥ 0.9, extubation time, and time to modified Aldrete score ≥ 9 ($p < 0.05$). RASS scores immediately and 10 minutes after extubation were higher in the S group ($p < 0.05$). No significant differences were observed between groups in VAS pain scores at any postoperative time point or in total opioid consumption ($p > 0.05$). Time to first postoperative flatus/defecation were shorter in the S group ($p < 0.05$).

Conclusion: The sugammadex administration in patients undergoing laparoscopic bariatric surgery could expedite reversal of neuromuscular blockade, shorten anesthesia recovery time, and facilitate gastrointestinal function restoration. It also improved postoperative quality of recovery without elevating pain intensity or increasing opioid consumption.

Keywords: enhanced recovery after surgery, laparoscopic bariatric surgery, neostigmine, quality of recovery, sugammadex

Introduction

The global prevalence of obesity and related metabolic disorders, including hypertension, coronary heart disease, diabetes mellitus, and obstructive sleep apnea, has risen substantially in recent years, representing a major public health burden.[1] Laparoscopic bariatric surgery is the most effective intervention for severe obesity and its comorbidities. However, obese patients often present with obstructive sleep apnea or obesity hypoventilation syndrome, placing them at high perioperative risk. Residual neuromuscular blockade (RNMB) following intraoperative muscle relaxant use may increase the risk of regurgitation, aspiration, hypoxemia, carbon dioxide retention, and even cardiac arrest.[2,3] Prompt and complete reversal of neuromuscular blockade is therefore critical to minimize RNMB and maintain airway patency in this high-risk population.

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Neostigmine, an acetylcholinesterase inhibitor, is widely used for reversal but has a ceiling effect and may cause incomplete reversal, particularly in patients with severe obesity. It also induces cholinergic adverse effects including bradycardia and bronchospasm, requiring co-administration of anticholinergic agents such as atropine.[4] Sugammadex is a selective antagonist that rapidly and completely reverses rocuronium- or vecuronium-induced neuromuscular blockade without affecting muscarinic receptors or plasma cholinesterase, thus avoiding the need for anticholinergic co-administration.[5,6] This profile is especially advantageous for obese patients with cardiovascular or respiratory comorbidities.

Previous studies confirm that sugammadex enables faster neuromuscular reversal than neostigmine.[7–12] However, most investigations focus only on reversal speed and completeness, while its effects on postoperative sedation, pain control, gastrointestinal function, and overall recovery quality remain poorly defined in patients undergoing laparoscopic bariatric surgery. As these patients are particularly vulnerable to postoperative respiratory complications and delayed recovery, clarifying the comprehensive effects of sugammadex is clinically important.

This study therefore evaluated the effects of sugammadex on neuromuscular recovery, sedation, pain management, and overall recovery quality in patients undergoing laparoscopic bariatric surgery. We hypothesized that sugammadex would accelerate neuromuscular reversal, anesthesia emergence, and gastrointestinal recovery, improve pain control and recovery quality, and support enhanced recovery after surgery in this population.

Materials and Methods

Study Participants

Ethical approval of this study was granted by the Ethics Committee of Shanxi Bethune Hospital (YXLL-2024-195), and the study was registered with the Chinese Clinical Trial Registry (ChiCTR2400093208). Written informed consent was obtained from all participants prior to enrollment. A total of 60 patients with a clinical diagnosis of metabolic syndrome who were scheduled to undergo elective laparoscopic sleeve gastrectomy under general anesthesia at Shanxi Bethune Hospital between December 2024 and May 2025 were included.

The sample size was calculated based on a pilot study with 10 patients in each group. In the pilot study, the Quality of Recovery-15 (QoR-15) scores (mean ± standard deviation [SD]) at 24 hours postoperatively were 120.93 ± 12.23 in the N group and 129.52 ± 10.11 in the S group. Using a two-sided test with a significance level (α) of 0.05 and a power ($1-\beta$) of 0.80, and assuming a 1:1 allocation ratio, a minimum of 27 patients per group was required (calculated using SAS 9.4, SAS Institute, Cary, NC, USA). To account for an anticipated 10% dropout rate, 30 patients were enrolled in each group.

Inclusion criteria were as follows: age between 18 and 50 years; body mass index (BMI) $\geq$ 32.5 kg/m^2; American Society of Anesthesiologists (ASA) physical status classification I–III; and New York Heart Association (NYHA) functional class I–II. Exclusion criteria consisted of a history of central nervous system or respiratory system disorders; severe hepatic or renal dysfunction; neuromuscular disorders; use of medications known to interact with rocuronium during the perioperative period; or inability to cooperate with the study or refusal to provide written informed consent.

This study was designed as a prospective, double-blind, randomized controlled trial (RCT). Randomization was conducted using a random number table generated with SPSS version 26.0 (IBM Corporation, Armonk, NY, USA). Participants were allocated in a 1:1 ratio to either the neostigmine group (N group) or the sugammadex group (S group). Both participants and outcome assessors were blinded to group allocation. At the end of surgery, the group assignment was revealed by the attending anesthesiologist via a sealed opaque envelope. Medications were prepared based on corrected body weight and administered intravenously. The N group received neostigmine 0.04 mg/kg with atropine 0.02 mg/kg, while the S group received sugammadex 2 mg/kg according to the medication package insert and previous research.[13–15] Both medications were diluted to a total volume of 10 mL using normal saline. All surgical procedures were carried out by the same surgical team. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Anesthetic Management

All investigators completed unified standardized training for QoR-15/ Richmond Agitation-Sedation Scale (RASS) assessments. Preoperative fasting was maintained for 6 hours for solid food and 2 hours for clear fluids. Mechanical bowel preparation was not performed. Upon arrival in the operating room, peripheral venous access was established.

Standard monitoring included electrocardiography, noninvasive blood pressure, pulse oximetry, end-tidal carbon dioxide partial pressure ($P_{et}CO_2$), and bispectral index (BIS). Neuromuscular monitoring was conducted using a Veryark- Train-of-four (TOF) device (Guangxi VERYARK Technology Co., Ltd., China), with bilateral electrode placement over the ulnar nerve at the wrist and a force transducer positioned between the right thumb and index finger. The temperature sensor surface was placed in contact with the intrinsic hand muscles. TOF stimulation of the adductor pollicis was applied at 50 mA, 2 Hz frequency, 200 μs pulse width, and 20-second intervals.

During the perioperative period, the principle of anesthetic medication management based on different weight standards formulated in the "Expert Consensus on Anesthesia Management for Obese Patients (2017)" in China was implemented.[16] Total Body Weight (TBW) represents the actual measured weight of the patient.

Ideal Body Weight (IBW) refers to the weight corresponding to a healthy body fat ratio that varies with age. It can be approximately calculated based on height and gender. A common simple formula is: for Male, Height −100 (cm); for Female, Height −105 (cm).

Adjusted Body Weight (ABW): The calculation of adjusted body weight takes into account the increase in lean body weight and drug distribution volume in obese individuals. Calculation formula: ABW (kg) = IBW (kg)+0.4 [TBW (kg)–IBW (kg)].
Lean Body Weight (LBW) represents the weight after removing fat. The most commonly used calculation formula is as follows:

$$\mathrm{LBW\ (kg)} = \frac{9270 \times \mathrm{TBW(kg)}}{6680 + (216 \times \mathrm{BMI\ (kg/m^2)})}\ \mathrm{(Male)}$$

$$\mathrm{LBW\ (kg)} = \frac{9270 \times \mathrm{TBW(kg)}}{8780 + (244 \times \mathrm{BMI\ (kg/m^2)})}\ \mathrm{(Female)}$$

Anesthesia induction was achieved with intravenous midazolam 0.05 mg/kg (TBW), sufentanil 0.5 μg/kg (LBW), and propofol 2 mg/kg (TBW). Following loss of consciousness, baseline neuromuscular calibration was conducted. Intravenous rocuronium 0.9 mg/kg (LBW) was administered, and endotracheal intubation was performed under direct laryngoscopy once the TOF count reached zero. Volume-controlled mechanical ventilation was initiated with the following parameters: oxygen flow at 2 L/min, FiO_2 of 40%, tidal volume set at 6 mL/kg (IBW), respiratory rate of 12 breaths/min, an inspiration-to-expiration ratio of 1:2, and a positive end-expiratory pressure of 5 cmH_2O (1 cmH_2O = 0.098 kPa). Ventilation was adjusted intraoperatively to maintain $P_{et}CO_2$ between 35–45 mmHg (1 mmHg = 0.133 kPa) and airway pressure < 30 cmH_2O.

Anesthesia was maintained via total intravenous anesthesia. Propofol infusion was titrated to sustain BIS values between 40 and 60. Remifentanil infusion was adjusted according to blood pressure and heart rate, with the aim of maintaining hemodynamic stability within ± 20% of baseline values. Neuromuscular blockade was continuously monitored, targeting a TOF count of 0 and post-tetanic count of 0–1. Supplemental doses of rocuronium 0.2–0.3 mg/kg (LBW) were administered if TOF count was ≥ 1. Pneumoperitoneum pressure was maintained between 12 and 16 mmHg. The operating room temperature was controlled at 24 °C, and active warming methods, including fluid warming and forced-air warming, were employed to maintain core body temperature above 36 °C.

All patients received intravenous palonosetron 0.25 mg thirty minutes prior to surgical completion to prevent postoperative nausea and vomiting. Rocuronium infusion was discontinued at the time of peritoneal closure, while propofol and remifentanil infusions were stopped at skin closure. Upon reappearance of T2 during neuromuscular monitoring, participants in the N group received neostigmine 0.04 mg/kg combined with atropine 0.02 mg/kg (ABW), whereas those in the S group received sugammadex 2 mg/kg (ABW). Extubation was performed once the TOF ratio recovered to ≥ 0.9, consciousness returned, and spontaneous breathing resumed. Patients were transferred to the post-anesthesia care unit and subsequently to the general ward once a modified Aldrete score of ≥ 9 was achieved. Multimodal postoperative analgesia consisted of: (1) ultrasound-guided rectus sheath block with 30 mL of 0.33% ropivacaine; (2) intravenous patient-controlled analgesia using sufentanil 100 μg diluted to 100 mL with normal saline, programmed with a 2 mL loading dose, 1 mL/h background infusion, 2 mL bolus dose, and a 15-minute lockout interval; and (3) intravenous ibuprofen 0.8 g administered every 12 hours.

Outcome Measures

Primary Endpoint

The primary endpoint was the QoR-15 score assessed 24 hours after surgery (Supplementary Table 1).

Secondary Endpoints

Secondary endpoints included the following: (1) time to achieve a TOF ratio ≥ 0.9, measured from administration of the neuromuscular blockade antagonist to attainment of TOF ratio ≥ 0.9; (2) anesthesia recovery time, defined as the interval from neuromuscular blockade antagonist administration to eye opening in response to verbal command; extubation time, defined as the interval from antagonist administration to removal of the endotracheal tube; and time to achieve a modified Aldrete score ≥ 9; (3) RASS scores assessed immediately after extubation and at 10, 30, and 60 minutes post-extubation; (4) Visual Analogue Scale (VAS) pain scores recorded immediately after extubation and at 10, 30, and 60 minutes post-extubation, as well as total opioid consumption within the first 48 postoperative hours; (5) time to first postoperative flatus/defecation; (6) incidence of adverse events, including postoperative nausea and vomiting, agitation, hypoxemia, bradycardia, and allergic reactions.

Statistical Analysis

Statistical analyses were conducted using SPSS 26.0 software (IBM Inc., New York, NY). Continuous variables with normal distribution are expressed as mean ± standard deviation () and compared using independent-samples *t*-tests. Repeated measures of normally distributed data were analyzed using repeated-measures analysis of variance. Non-normally distributed continuous variables are presented as median (interquartile range) and compared using the Mann–Whitney *U*-test; repeated measures were assessed using generalized estimating equations (GEE). Categorical variables are reported as frequencies or percentages and compared using chi-squared tests. A value of $p < 0.05$ is considered statistically significant.

Results

Baseline Characteristics

A total of 75 patients scheduled for elective laparoscopic sleeve gastrectomy under general anesthesia were initially assessed for eligibility. Participation was declined by 8 patients, and 7 were excluded for not meeting the inclusion criteria (n = 2, age > 50 years; n = 3, age < 18 years; n = 1, NYHA class III; n = 1, BMI < 32.5 kg/m^2). Ultimately, 60 patients were enrolled in the study. The participant selection process is illustrated in Figure 1.

No statistically significant differences were identified between groups in sex distribution, age, BMI, ASA physical status classification, surgical duration, or anesthesia duration ($p > 0.05$) (Table 1). Perioperative anesthetic drug consumption, intraoperative fluid intake, and estimated blood loss were comparable between the two groups ($p > 0.05$) (Table 1).

Primary Endpoint

Baseline QoR-15 scores, assessed 24 hours preoperatively, were comparable between the two groups ($p > 0.05$). QoR-15 scores at 24 hours postoperatively were significantly higher in the S group compared with the N group (129.00 [126.00,132.00] vs 120.00 [115.75,123.75]; Z = - 4.866, p < 0.001), with the intergroup Cohen's d was 1.547 (95% CI: 1.014 to 2.293), indicating statistically significant and clinical large effects (Table 2).

Secondary Endpoints

Anesthesia recovery time was markedly shorter in the S group compared with the N group (5.97 ± 1.50 vs 9.97 ± 2.99; t = 6.555, p < 0.001), with a mean difference of −4.00 (95% CI: −5.22 to −2.78, p < 0.001) (Table 3).

The anesthesia extubation time was significantly shorter in the S group than the N group (6.73 ± 1.36 vs 14.77 ± 3.18; t = 12.716, p < 0.001), with a mean difference of −8.00 (95% CI: −10.00 to −6.00, p < 0.001) (Table 3).

The time required to achieve a TOF ratio ≥ 0.9 was significantly reduced in the S group than the N group (3.00[3.00, 4.00] vs 11.50 [9.00, 14.75]; Z=−6.696, p < 0.001), with a median difference of −8.00 (95% CI: −10.00 to −7.00, p < 0.001) (Table 3).

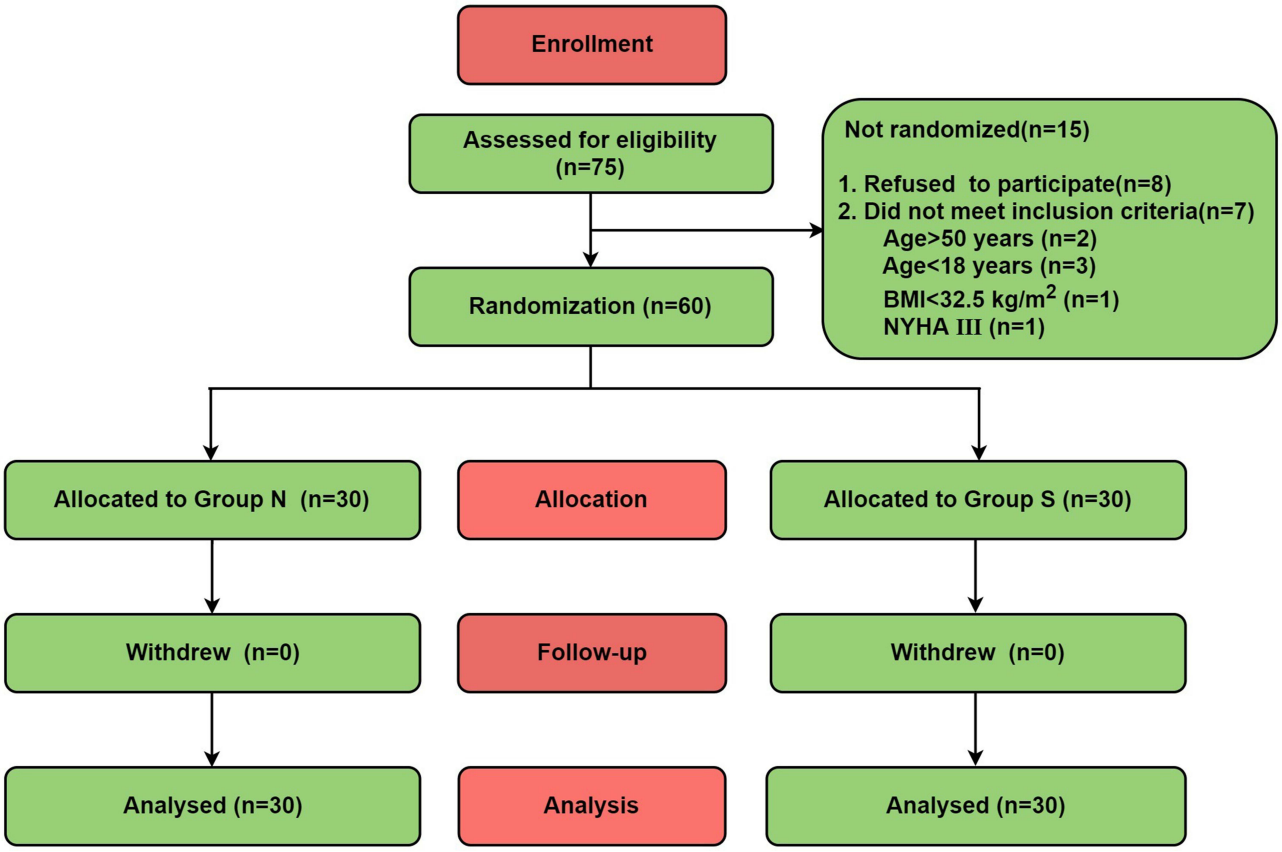

Figure 1 Participant flow diagram.
Abbreviations: Group N, Neostigmine Group; Group S, Sugammadex Group; BMI, denotes Body Mass Index; NYHA, denotes New York Heart Association.

The time to reach a modified Aldrete score ≥ 9 and first postoperative flatus/defecation were both significantly reduced in the S group compared to the N group (all $p < 0.001$) (Table 3).

The incidence of postoperative nausea and vomiting did not differ significantly between the groups ($p > 0.05$) (Table 3). No other adverse reactions were reported in either group.

Table 1 Baseline Characteristics of Patients in Both Groups

Variables	N Group (n = 30)	S Group (n = 30)	Statistic	*p*-value
Sex (Male/Female)	7/23	11/19	χ^2=1.270	0.260
Height (cm)	164.5±8.2	167.5±8.2	*t*=1.431	0.158
Weight (kg)	114.0±18.7	116.9±21.6	*t*=0.540	0.591
BMI (kg/m^2)	42.1 ± 5.8	41.5 ± 6.1	*t*=0.414	0.681
Age (years)	34.0 ± 8.7	33.0 ± 5.9	*t*=0.521	0.604
ASA classification (II/III)	28/2	26/4	χ^2=0.185	0.667
Surgical duration (min)	108.5 ± 24.4	109.8 ± 24.7	*t*=−0.216	0.830
Anesthesia duration (min)	134.8 ± 24.1	136.2 ± 22.9	*t*=−0.225	0.823
Propofol consumption (mg)	800 (700, 878)	735 (645, 945)	Z=−0.681	0.496
Remifentanil consumption (μg)	1749.3 ± 378.7	1799.3 ± 510.9	*t*=−0.431	0.668
Rocuronium consumption (mg)	107.6 ± 25.3	111.1 ± 29.3	*t*=−0.496	0.622
Fluid intake (mL)	1000 (625, 1000)	1000 (1000, 1000)	Z=−0.264	0.792
Blood loss (mL)	65 (50, 100)	60(50, 100)	Z=−0.099	0.921

Abbreviations: N group, neostigmine group; S group, sugammadex group; BMI, body mass index; ASA, American Society of Anesthesiologists.

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Table 2 Comparison of Quality of Recovery-15 (QoR-15) Scores

Variables	N Group (n = 30)	S Group (n = 30)	Statistic	*p*-value
QoR-15 at 24 h preoperatively (points)	144.5 (140.5, 148.0)	145.0 (142.0, 148.0)	Z= −0.268	0.788
QoR-15 at 24 h postoperatively (points)	120.0 (115.8, 123.8)	129.0 (126.0, 132.0)	Z= −4.866	<0.001

Abbreviations: N group, neostigmine group; S group, sugammadex group; QoR-15, Quality of Recovery-15.

Table 3 Postoperative Outcomes in the Two Groups

Variables	N Group (n = 30)	S Group (n = 30)	Statistic	*p*-value
Anesthesia recovery time (min)	10.0 ± 3.0	6.0 ± 1.5	t=6.555	<0.001
Time to TOF ratio ≥0.9 (min)	11.5 (9.0, 14.8)	3.0 (3.0, 4.0)	Z=−6.696	<0.001
Extubation time (min)	14.8 ± 3.2	6.7 ± 1.4	t=12.716	<0.001
Time to modified Aldrete score ≥9 (min)	30.0 (25.0, 35.0)	22.0 (20.0, 23.8)	Z=−4.899	<0.001
Time to first flatus (h)	28.0 (25.3, 29.0)	22.0 (20.0, 24.0)	Z=−5.918	<0.001
Time to first defecation (h)	53.3 ± 2.1	49.9 ± 2.3	t=5.916	<0.001
Nausea and vomiting [n (%)]	3 (10.0)	1 (3.3)	χ^2=0.268	0.605

Abbreviations: N group, neostigmine group; S group, sugammadex group; TOF, train-of-four.

Table 4 Comparison of Postoperative Richmond Agitation-Sedation Scale (RASS) Scores, Visual Analogue Scale (VAS) Pain Scores, and Sufentanil Consumption

Variables	N Group (n = 30)	S Group (n = 30)	Statistic	*p*-value
RASS score immediately after extubation (points)	0.0 (−1.0, 0.0)	0.0 (0.0, 0.0)	Z=2.305	0.021
RASS score at 10 min post-extubation (points)	0.0 (−0.8, 0.0)	0.0 (0.0, 0.0)	Z=2.498	0.012
RASS score at 30 min post-extubation (points)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	Z=0	1
RASS score at 60 min post-extubation (points)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	Z=0	1
VAS score immediately after extubation (points)	3.0 (2.0, 3.0)	3.0 (3.0, 3.0)	Z=−0.763	0.445
VAS score at 10 min post-extubation (points)	3.0 (2.0, 3.0)	3.0 (2.0, 3.0)	Z=−0.446	0.655
VAS score at 30 min post-extubation (points)	2.0 (2.0, 3.0)	2.0 (2.0, 3.0)	Z=−0.151	0.880
VAS score at 60 min post-extubation (points)	2.0 (2.0, 3.0)	2.0 (2.0, 3.0)	Z=−0.347	0.729
Postoperative sufentanil consumption (μg)	56.3±5.3	54.5±4.6	t=1.447	0.153

Abbreviations: N group, neostigmine group; S group, sugammadex group; RASS, Richmond Agitation-Sedation Scale; VAS, Visual Analogue Scale.

Significantly higher RASS scores were observed in the S group immediately after extubation and at 10 minutes post-extubation ($p < 0.05$), with no significant differences found at subsequent time points ($p > 0.05$) (Table 4).

VAS pain scores indicated no statistically significant effects of time, group, or interaction ($p > 0.05$) (Table 4). Total sufentanil consumption via patient-controlled analgesia within 48 hours postoperatively was similar between the two groups ($p > 0.05$) (Table 4).

Discussion

The present study demonstrated that, compared with neostigmine, sugammadex expedited the achievement of a TOF ratio ≥ 0.9 and a modified Aldrete score ≥ 9, shortened anesthesia recovery, extubation, and first flatus/defecation times, and significantly improved QoR-15 scores at 24 hours postoperatively without increasing pain intensity or opioid consumption in patients undergoing laparoscopic bariatric surgery.

The QoR-15 scale is a well-established instrument for evaluating early postoperative recovery quality.[17–20] Myles et al suggested that a change of at least 6 points represents the minimal clinically important difference for this scale.[21,22] In the present study, QoR-15 scores were significantly higher in the sugammadex group, with a Cohen's d of 1.547 (95% CI: 1.014 to 2.293), indicating both statistically significant and clinically large effects. These findings support that sugammadex improves overall early recovery beyond conventional reversal agents.

Anesthesia recovery time, extubation time, and time to reach a modified Aldrete score ≥ 9 were also significantly shorter in the sugammadex group. These results indicate enhanced early postoperative recovery and patient comfort. Kim et al reported similar improvements in physiological recovery with sugammadex in ambulatory surgery.[23] The underlying mechanism likely involves rapid elimination of muscle relaxants, reduced residual blockade, and diminished interference with respiratory and circulatory function. Notably, the most direct mechanism underlying these improvements is the complete neuromuscular recovery achieved by sugammadex, which directly meets the criteria for safe tracheal extubation and thereby accelerates anesthesia emergence.

RASS sedation scores immediately and 10 minutes after extubation were higher in the sugammadracs group, indicating earlier and smoother emergence. Guen et al reported comparable findings with increased BIS values following sugammadex administration.[24] According to the differentiation theory, neuromuscular blocking agents reduce afferent input from muscle spindles and suppress cortical activity. Rapid reversal by sugammadex restores muscle spindle function and afferent signaling, which may promote arousal and emergence from anesthesia.[25,26] Because direct evidence in this field remains limited, further studies are needed to clarify the precise mechanisms.

Patients with obesity frequently experience severe postoperative pain and require higher opioid doses after laparoscopic bariatric surgery. Sugammadex has been associated with reduced respiratory complications, but its effect on postoperative pain remains controversial. Castro et al reported lower pain scores and analgesic requirements with sugammadex in bariatric surgery,[13] whereas Oh et al observed increased analgesic use after gastric cancer surgery.[27] Emery et al proposed that restored muscle tone may lead to earlier perception of surgical pain.[28]

In the present study, however, no significant differences were detected in VAS pain scores or total opioid consumption between groups. This may be explained by the standardized multimodal analgesia regimen, including ultrasound-guided rectus sheath block, patient-controlled analgesia, and intravenous ibuprofen, which provided effective and balanced pain control in both groups. Moreover, co-administration of atropine with neostigmine may have mitigated its prokinetic and pronociceptive effects. The relatively small sample size may also have limited the detection of subtle between-group differences.

Laparoscopic bariatric surgery is often complicated by postoperative ileus due to pneumoperitoneum, intestinal manipulation, and anesthesia-related gastrointestinal suppression. Vaghiri et al showed that sugammadex accelerates bowel motility recovery compared with acetylcholinesterase inhibitors.[29] Our study similarly demonstrated shorter times to first flatus and defecation in the sugammadex group.[30–37] This benefit may be attributed to the lack of interaction between sugammadex and the cholinergic system. Unlike neostigmine, sugammadex does not require anticholinergic co-administration, which can impair intestinal motility.[31] Sugammadex may also sequester steroid hormones that inhibit gastrointestinal motility, further promoting recovery.[36,38]

Postoperative nausea and vomiting (PONV) are common after bariatric surgery. In the present study, the incidence of PONV did not differ significantly between groups, consistent with a meta-analysis by Subramani et al in morbidly obese patients.[39] Although sugammadex may improve respiratory function and reduce CO_2-related PONV triggers, routine long-acting antiemetics likely minimized between-group differences. Ding et al reported reduced PONV with sugammadex in bariatric surgery,[30] but such differences may be obscured by comprehensive antiemetic prophylaxis. The relatively small sample may also limit detection of significant differences.

Although sugammadex is more costly than neostigmine/atropine, it significantly shortened multiple intraoperative and postoperative time metrics, including anesthesia recovery, extubation, time to modified Aldrete score ≥9, and time to first flatus and defecation. These improvements may reduce PACU length of stay, improve operating room turnover, and enhance hospital efficiency, potentially offsetting higher drug costs.[40,] For obese patients, especially those with obstructive sleep apnea and high risk of residual neuromuscular blockade, the rapid, predictable reversal provided by sugammadex reduces the risk of respiratory compromise and supports safer recovery.

Despite higher acquisition costs, the favorable recovery profile and safety advantages suggest that sugammadex provides clinically meaningful benefits over neostigmine/atropine in patients undergoing laparoscopic bariatric surgery. Further studies with formal cost-effectiveness analyses are warranted to confirm its economic and clinical value in this high-risk population.

Limitation

This study has several limitations. First, the single-center design and relatively small sample size may have reduced statistical power, and the lack of multicenter validation limits generalizability despite the use of randomization. Second, perioperative

unblinding risk was present: the characteristic rapid neuromuscular blockade reversal effect of sugammadex may have enabled assessors to identify intervention groups via objective parameters, introducing assessment bias. To mitigate this in future research, objective blinding verification strategies are recommended, including standardized blinded confidence surveys for outcome assessors at key perioperative time points and third-party independent analysis of physiological indicators to ensure blinding integrity. Third, the study only assessed short-term postoperative recovery at 24 hours, without evaluating long-term outcomes. Fourth, this was a single-center study with a relatively homogeneous ethnic population, and the follow-up period was limited to 24 hours postoperatively. Future large-scale, multicenter studies with diverse ethnic populations and longer follow-up durations (eg, assessment using the QoR-40 quality of recovery scale at 7 days postoperatively) are warranted to validate the long-term benefits of sugammadex in this population. Future research should incorporate multicenter designs, larger sample sizes, extended follow-up periods, and comprehensive assessment tools for postoperative pain and gastrointestinal function, and implement the aforementioned blinding checks to more thoroughly assess the clinical utility of sugammadex.

Conclusion

In summary, sugammadex administration in patients undergoing laparoscopic bariatric surgery could expedite reversal of neuromuscular blockade, shorten anesthesia recovery time, and facilitate gastrointestinal function restoration. It also improved postoperative quality of recovery without elevating pain intensity or increasing opioid consumption.

Trial Registration

Full name of the registry: Chinese Clinical Trial Registry (https://www.chictr.org.cn)

Trial registration number: ChiCTR2400093208

Date of registration: 2024.11.29

Data Sharing Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

Ethics Approval and Consent to Participate

This study was conducted with approval from the Ethics Committee of Shanxi Bethune Hospital (YXLL-2024-195). This study was conducted in accordance with the declaration of Helsinki. Written informed consent was obtained from all participants.

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Disclosure

The authors declare that they have no competing interests.

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