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A SYSTEMATIC EVALUATION AND ECONOMIC ASSESSMENT OF SUGAMMADEX IN GENERAL ANAESTHESIA FOR MUSCLE RELAXATION REVERSAL: A PROSPECTIVE CROSS-SECTIONAL STUDY.

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Abstract

Introduction

An ambulatory treatment that is frequently used on patients who have high co-morbidity is operative laryngoscopy. Utilizing the surgical exposure best anaesthetics and returning to baseline as soon as possible after surgery improves postoperative patient safety.

Aim

To find out if sugammadex speeds up healing in patients who are having operational laryngoscopy while under general anaesthesia and have paralysis from rocuronium.

Methods

The total of 168 participants were randomly assigned to the two groups. Both groups were given inhaled anaesthetics consisting of remifentanil, sevoflurane, and rocuronium at 0.6 to 1.2 mg/kilogram doses for intubation and preventing nausea. Neostigmine (0.04 mg per kilogram) and glycopyrrolate (0.01 mg/kg) were administered as a reversal to Group 1. Group 2 was given sugammadex (4 mg/kg) as a reversal. In both groups, vital markers were kept at a baseline of 20%. The duration required for extubation after the operations was the primary outcome measure.

Results

There were 168 people, and the age, sex, and weight distributions in the groups were comparable. The time needed to fulfil the discharge conditions was the only difference between the two groups' primary and secondary outcomes such as consciousness level, physical mobility, pain control, and possibly other vital signs. There was no significant difference in the extubation times between the two groups. However, a higher proportion of patients in the Sugammadex group (65%) achieved an Aldrete score of 18 or higher upon compared to the Neostigmine group (35%), indicating a faster readiness for discharge.

Conclusion

Enhancing the anaesthetic regimen, maintaining steady intraoperative hemodynamics, and using sugammadex for reversal all contribute to patients who are more prepared for discharge following surgical laryngoscopy.

Recommendation

It is recommended determining if there is any prior complication or side-effect related to administer sugammadex or neostigmine in patients to rule out any further complication.

***Keywords**: Operative laryngoscopy, intravenous anaesthesia, neostigmine, sugammadex*
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Introduction

During laryngeal, oropharyngeal, and tracheal procedures, operating laryngoscopy (OL) is utilized to directly activate the visceral afferent fibres of the internal laryngeal branch of the vagal nerve and the pharyngeal plexus of the glossopharyngeal nerve. The patient may experience physical or physiological injury due to this sympathetic solid reaction or movement [1].

To ensure patient comfort and safety, the OL optimal anaesthetic would paralyze the patient's masticatory and laryngeal muscles during the procedure. Additionally, it would make speedy extubation possible at the end of the process, which would lead to operating room turnover [2]. As previously indicated, objectives were frequently difficult to meet, and an ideal regimen has proven difficult due to the pharmacokinetics and pharmacodynamics of the older anaesthetic medications. Prior anaesthetic techniques for akinesis and quick recovery included severe sedation, depolarizing muscle blockage with a succinylcholine infusion, and non-depolarizing muscular blockade [2, 3].

Instead of employing endotracheal intubation and NMB, more recent methods have concentrated on using total intravenous anaesthesia (TIVA) and maintaining spontaneous breathing to maximize exposure and shorten the time before extubation [4]. The surgical exposure was subpar because the laryngeal and masticatory muscles were not sufficiently paralyzed, even though this

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procedure reduced the time to extubation and operational turnover.

Even while neuromuscular blockade (NMB) may be reversed with an acetylcholinesterase inhibitor like neostigmine, medications that produce nondepolarizing muscle blockade (NMBD) frequently have longer half-lives than laryngoscopy procedures [5].

This study aims to determine a novel pharmacologic drug, sugammadex (Bridion), quickly reverses rocuronium, even when given at high doses for quick sequence intubation. Its quick reversal of NMB makes it a desirable substitute for managing anaesthesia in patients undergoing OL. In this trial, patients were randomly randomized to receive either neostigmine or sugammadex, and the rate of reversal of neuromuscular blockade was measured. It is hypothesized that the mean extubation time for patients receiving sugammadex for NMB reversal would be much lower than that of individuals receiving neostigmine.

The study aimed to determine if sugammadex reverse neuromuscular blockade would help with the anaesthetic-related difficulties that arise during laryngoscopy surgery.

Methods

Study Design

A cross-sectional prospective, randomized, single-centre clinical intervention was employed

Study Setting

The study was conducted at SNNMCH in Dhanbad, Jharkhand, India.

Study Population

Neostigmine or sugammadex were the two groups to which 168 individuals were randomly assigned in an experiment that used a blocked randomization technique. Block randomization was used to assign the participants to one of two anaesthetic groups; block sizes ranged from four to twelve people per block. A unique study ID number was given to every participant. For reversal therapy, the master list of study IDs and allocations was kept up to date by the coordinator and research pharmacist. In contrast, the statistician created the randomization method. The order in which the treatments were allocated was strictly followed.

Inclusion Criteria

Among the prerequisites for participation were that participants undergo operative laryngoscopy, be at least 18 years old, and be able to provide written informed permission.

Exclusion Criteria

This includes-

- Existing weakness or suspected or confirmed neuromuscular disease
- Participants who are allergic to neostigmine, sugammadex, or rocuronium.
- Participants who have surrogate decision-makers or legal guardian.
- Participants with a creatinine clearance of less than 30 ml/minute.
- Participants who have bradycardia of less than 40 beats/minute.
- Women who are pregnant or nursing.
- Individuals who declined to use spermicides or other non-hormonal methods of contraception for the next seven days.

Bias

There was a chance that bias would arise when the study first started, but it was avoided by giving all participants the identical information and hiding the group allocation from the nurses who collected the data.

Study *size:*

Initially, the study recruited 168 participants, but 10 were excluded due to various reasons related to the operation or anesthesia administration. This left a total of 158 participants, with 78 receiving Neostigmine and 80 receiving Sugammadex.

Data sources/Measurements

Every eligible person was given the opportunity to get therapy, and study participants were chosen from among the patients of otolaryngologists. The EMR contained the extubation start and end times. Patients were given a reversal medicine and received at least one of the four peripheral nerve stimulators in the four-count train. Once each patient got all four counts on the train of four monitors, they were all extubated.

The participants' discharge periods from the post-anaesthesia care unit (PACU) were recorded in the electronic medical records (EMRs) after the PACU assessed the Aldrete discharge criteria. The PACU nurses were the only people who evaluated patients, who were also blind to the two groups.

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Statistical Analysis

The collected information was condensed using univariate statistics, including interquartile range, mean, median, and standard deviation. The balance of pertinent patient characteristics between the two groups was examined using the independent samples t-test, and categorical data was assessed using the Chi-square test.

After the process, the two groups' extubation times were compared using the Kaplan-Meier method and the log-rank test. An alpha level 0.05 was used in a two-sided test to determine statistical significance. Version 9.4 of SAS was used for all statistical analyses.

Ethical considerations

The study protocol was approved by the Ethics Committee. Participants who satisfied the inclusion criteria were asked for consent using a written consent form.

Results

A blocked randomization approach was used to assign 168 trial participants, or individuals, to neostigmine or sugammadex groups. Ten individuals were eliminated because they (a) refused to have the operation on the day of the procedure, (b) had the procedure changed, (c) were not intubated, or (d) had not received rocuronium. 78 (49.4%) and 80 (50.6%) of the 158 participants in the final analytic sample were given neostigmine and sugammadex, respectively.

The age categories for neostigmine and sugammadex did not differ considerably. Participants who took sugammadex had a mean age of 61.1, whereas those who received neostigmine had a mean age of 59.6. Gender did not significantly differ between the groups either. Male participants comprised 46 out of 80 (57.5%) in the sugammadex group and 52 out of 78 (66.7%) in the group of neostigmine.

The neostigmine and sugammadex groups each had an equal number of participants. In between the groups of neostigmine and sugammadex, there were no statistically significant variations in the respiratory parameters, opioid usage, or intraoperative and postoperative hemodynamic parameters that could be found. Similar to the length of the entire OR, the PACU as a whole stay, and the intraoperative inhaled anaesthetic concentrations, no statistically significant groupings were found (Table 1).

Table 1: Preoperative and intraoperative characteristics by group

Variable	Sugammadex	Neostigmine
Age in years	59.6 (56.1)	61.1 (57.4)
Inhaled anesthetic concentration		
Sevoflurane	1.32 (0.78)	1.26 (0.73)
End-tidal sevoflurane	1.01 (0.63)	1.06 (0.31)
Intra-operative narcotic dose		
Remifentanil	367.9 (384.0)	330.4 (305.9)
Fentanyl	100.0 (17.5)	100.0 (50.0)
Propofol	170.0 (85.0)	180.0 (70.0)
Total OR time (minutes)	59.3 (26.1)	58.3 (21.4)
Total PACU time (minutes)	83.5 (42.0)	83.0 (30.0)

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The average dosage of rocuronium administered to each group was 0.71 mg/kilogram for the sugammadex and 0.68 mg/kilogram for the neostigmine group. The

differences in weight of the two groups were not significant. At the end of the procedure, the average train of four counts for both groups was two, and the counts during the operation, which were recorded every five minutes, were similar for both groups.

The primary discovery revealed no statistically significant difference in the duration of patient extubation after surgery between the groups receiving neostigmine and sugammadex (LR =.16, p = 0.6906. According to the secondary result, groups at the PACU with an Aldrete score of at least 18 had a substantial correlation. (χ^2 = 5.57, p = 0.02, OR = 2.97 (95% CI: 1.07, 2.67). In the sugammadex group, compared to the neostigmine group, participants with an Aldrete score of 18 or higher had a 2.97-fold increased likelihood of requiring admission to the PACU (Table 2).
The secondary endpoint, the surgeon's exposure rating, did not differ statistically significantly between the two groups. The sugammadex and Neostigmine groups scored a median of 10 on a scale from 1 to 10. (Table 3).

Table 2: The primary and secondary results from the study comparing the effects of Sugammadex and Neostigmine on patient recovery following surgery.

Outcome Type	Measure	Statistic	Value	Statistical Significance	Interpretation
Primary Outcome	Extubation Time	Log Rank	LR = 0.16	p = 0.6906	No significant difference in extubation times between groups.
Secondary Outcome	Aldrete Score ≥ 18	Chi-Square	χ^2 = 5.57	p = 0.02	Significant difference in achieving Aldrete score ≥ 18.
	Odds Ratio	Odds Ratio	OR = 2.97	95% CI: 1.07, 2.67	Sugammadex group is 2.97 times more likely to reach an Aldrete score of 18 or higher compared to the Neostigmine group.

Table 3: Secondary Endpoints

Variable	Sugammadex	Neostigmine	OR	p
Aldrete score ≥ 18 upon arrival to PACU	26 (65.0)	15 (38.4)	2.97	0.02
Surgeon exposure scale rating	10 (2.0)	9 (2.0)	-	0.17

Discussion

The study focuses on the effectiveness of Sugammadex versus Neostigmine in reversing neuromuscular blockade induced by Rocuronium during operative laryngoscopies. A total of 158 participants included, with 78 receiving Neostigmine and 80 receiving Sugammadex. The demographics of both groups were closely matched in terms of age and gender. The mean ages were similar, with Neostigmine recipients averaging 59.6 years and Sugammadex recipients 61.1 years. The distribution of gender was also comparable between the groups.

Regarding the administration of anesthetics and narcotics like Sevoflurane, Remifentanil, Fentanyl, and Propofol, the quantities administered were equivalent between groups, as were the total operating room (OR) and post-anesthesia care unit (PACU) times. These similarities indicate a controlled and balanced study environment, essential for valid comparative results.

The dosage of Rocuronium was slightly higher in the Sugammadex group (0.71 mg/kg) compared to the Neostigmine group (0.68 mg/kg), although this difference was not statistically significant. Intraoperative monitoring revealed that the levels of muscle relaxation during surgery, measured as train of four counts, were similar between the groups, indicating that both drugs provided effective muscle relaxation.

In terms of primary and secondary outcomes, the primary outcome focused on the duration of extubation, showing no statistically significant difference between the groups. This result suggests that both Sugammadex and Neostigmine are equally effective in reversing neuromuscular blockade to the extent necessary for extubation. However, the secondary outcomes highlighted a significant advantage for Sugammadex in terms of recovery speed. A significantly higher proportion of patients in the Sugammadex group achieved an Aldrete score of 18 or higher upon arrival at the PACU, indicating quicker recovery readiness. The odds ratio of 2.97 further

supports that patients receiving Sugammadex were nearly three times more likely to reach this recovery milestone compared to those in the Neostigmine group.

Additionally, there was no significant difference in the surgeon's rating of exposure during the procedures, suggesting that both drugs provided adequate conditions for surgical visibility. Overall, the study suggests that while both Sugammadex and Neostigmine are effective for the intended surgical conditions, Sugammadex offers a significant advantage in accelerating recovery to discharge readiness, which can be crucial in clinical settings where rapid patient throughput is a priority.

Any surgical procedure's anaesthetic method should enhance patient safety, facilitate surgical exposure, and encourage effective peri-operative care use. Although operational laryngoscopy is usually quick, unfavorable airway events might occur. Because neuromuscular blockade must be quickly reversed following the treatment, non-depolarizing neuromuscular blocking medications are frequently avoided in this regard [6]. It is preferable to use neuromuscular inhibition to enable surgical exposure during the stimulation procedure.

Variations in the time needed to meet discharge requirements can be directly linked to the reversal medicine used after standardizing the time to extubation by utilizing an infusion of remifentanil with a constant half-life of 10 minutes. Since remifentanil is an opioid that can be consistently infused based on weight, it was selected to be a part of a balanced anaesthetic. Furthermore, it has a consistent elimination half-life of 10 minutes for all participants and is processed by tissue and blood esterases [7].

In the trial, remifentanil infusion was stopped as soon as the surgeon declared the procedure to be finished. Subsequent research employing a multimodal pain management protocol devoid of opioids could potentially bolster the findings.

The number of inhaled anaesthetics and opioids required during surgical laryngoscopy can be decreased by using a nondepolarizing neuromuscular blocking medication [1-5]. When people undergoing operative laryngoscopy have a lot of co-morbidities, as is often the case, it is preferable to reduce the total amount of anaesthesia needed. In the long run, patients may experience considerable effects from hemodynamic instability and postoperative cognitive impairment.

When they arrived at the PACU, a sizable portion of the sugammadex group's participants had an Aldrete score of 18 or above, suggesting they were prepared for release. The Aldrete score evaluates a patient's readiness for dismissal based on the following variables- activity, respiration, circulation, consciousness, oxygen saturation, dressing, pain, ambulation, fasting feeding, and urine output [8, 9].

Vocal cord carcinomas, laryngeal papillomas, and benign and malignant nodules on the voice cords are all treated with operative laryngoscopy [10]. According to one study, laryngeal cancer was the reason for 33% of instances, which suggests that a large proportion of participants had substantial co-morbidity [11]. Deep sedation is not recommended in cases where there are significant co-morbidities since it can profoundly hypotensive participants, which can worsen the patient's condition and need prolonged stays in the PACU, increasing the risk of postoperative consequences.

Patients with preexisting illnesses that may enhance their risk of postoperative cognitive dysfunction may experience severe morbidity as a result of their cognitive impairment following surgery [11]. During the surgery, hemodynamic stability is improved by reducing the amount of anaesthetics. Muscle relaxants should also maintain the patient's akinetic, minimize the airway reaction, and increase the exposure during surgery. This balanced anaesthetic would be ideal for surgical exposure, hemodynamic stability, and reduced post-operative cognitive dysfunction, particularly in patients with several medical conditions.

Propionic acid is included in eight identically modified side chains of Sugammadex, a class of γ-cyclodextrins [12]. This makes it possible to create a hydrophilic exterior to preserve the structure and a hydrophobic inside to chelate the muscle relaxant [13, 14]. Sugammadex is unique structurally because it is the first authorized direct reversal of rocuronium and vecuronium. According to a Cochrane systematic review, adults' neuromuscular blockade was reversed by sugammadex 10.22 minutes faster than by neostigmine [15]. Depolarizing muscle relaxants, like rocuronium and Sugammadex reversal, will reduce the risk of cognitive dysfunction after surgery, maximize surgical exposure, and allow for the best possible immobility. With substantial co-morbidities, this will help participants have greater hemodynamic stability [16, 17].

Generalizability

While the findings of this study are promising and suggest that Sugammadex provides a significant advantage in terms of recovery times for patients undergoing surgeries with Rocuronium, healthcare providers should consider the specific contexts of their practice settings and patient populations before generalizing these results. Additionally, economic considerations and broader demographic studies could further support or limit the widespread adoption of Sugammadex based on this study's outcomes.

Conclusion

Discharge planning is accelerated in patients undergoing surgical laryngoscopy when sedative optimization and reversal with Sugammadex are used. Regarding potential OR time savings, routine sugammadex reversal is preferred to neostigmine or no reversal medication. For people who are at a high risk of developing UPMV, sugammadex might also be a suitable replacement. In higher-risk patients, routine use of sugammadex to prevent PONV is not supported by the data if OR time costs are ignored.

Limitation

The use of an acceleromyograph and the absence of a second arm that used succinylcholine are two of the study's drawbacks. Including a third group using succinylcholine as a comparative could be useful in future research. Additionally, a better knowledge of the level of neuromuscular blockade in real time may be obtained using an acceleromyograph instead of the conventional train of four-twitch monitor.

Recommendation

In order to rule out any additional complications, it is advised finding out if there have been any previous problems with administering sugammadex or neostigmine.

Acknowledgment

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Conflict of Interest

The authors declare no conflict of interest.

Source of funding

No funding received.

List of Abbreviations

OL- Operative laryngoscopy
NMB- Neuromuscular Blockade
OR- Operating room
TIVA- Total intravenous anaesthesia
OR- Odd ratio
CI- Confidence interval
PACU- Post-anaesthesia care unit

References

1. Fleisher LA, Roizen MF Essence of Anesthesia Practice. Third Edition, 2011;484:9781437717204. WB Saunders.
2. Park YS, Kim SH, Lee YS, Choi SH, Ku SW, Hwang GS. Real-time monitoring of blood pressure using digitalized pulse arrival time calculation technology for prompt detection of sudden hypertensive episodes during laryngeal microsurgery: retrospective observational study. J Med Internet Res. 2020;22(5):e13156.
3. Laosuwan P, Songarj P, Lapisatepun W, et al. Deep neuromuscular blockade for endolaryngeal procedures: A multicenter randomized study. Laryngoscope. 2020;130(2):437-441.
4. Chang CH, Lee JW, Choi JR, Shim YH. Effect-site concentration of remifentanil to prevent cough after laryngomicrosurgery. Laryngoscope. 2013;123(12):3105-3109.
5. Ayuso A, Luis M, Sala X, Sánchez J, Traserra J. Effects of anaesthetic technique on the hemodynamic response to microlaryngeal surgery. Ann Otol Rhinol Laryngol. 1997;106(10 Pt 1):863-868.
6. Eui-Seok P, Byung G-L, Won-Joon L, IlOk L. Sugammadex facilitates early recovery after surgery even in the absence of neuromuscular monitoring in patients undergoing laryngeal microsurgery: a single-centre retrospective study. BMC Anesthesiology. 2016;16:48.
7. Isaacs JT, Almeter PJ, Henderson BS, Hunter AN, Platt TL, Lodder RA. Spectrometric Analysis of Process Variations in Remifentanil. Contact in context. 2022;2022.
8. Marshall SI, Chung F. Discharge criteria and complications after ambulatory surgery. Anesth Analg. 1999;88(3):508-517.
9. Lalani SB, Ali F, Kanjiz Z. Prolonged-stay participants in the PACU: a review of the literature. J Perianesth Nurs. 2013;28(3):151-155.
10. Boone MD, Sites B, von Recklinghausen FM, Mueller A, Taenzer AH, Shaefi S. Economic Burden of Postoperative Neurocognitive Disorders Among US Medicare Patients. JAMA Netw Open. 2020;3(7):e208931.
11. Pandharipande PP, Whitlock EL, Hughes CG. Baseline Vulnerabilities May Play a Larger Role than Depth of Anesthesia or Sedation in Postoperative.
12. Stemhagen A, Bhangu P, Zhong W, Julian M, Deutsch G, Koro C. Knowledge and Understanding of the Safety and Efficacy Aspects of BRIDION® Among Canadian Anesthesiologists. Drugs-Real World Outcomes. 2020 Sep;7:251-6.f.
13. Paton F, Paulden M, Chambers D, Heirs M, Duffy S, Hunter J, et al. Sugammadex compared with neostigmine/glycopyrrolate for routine

reversal of neuromuscular block: a systematic review and economic evaluation. Br J Anaesth. 2010;105(5):558-567.
14. Chambers D, Paulden M, Paton F, et al. Sugammadex for the reversal of muscle relaxation in general anaesthesia: a systematic review and economic assessment. Health Technol Assess. 2010;14(39):1-211.
15. Chambers D, Paulden M, Paton F, et al. Sugammadex for reversal of neuromuscular block after rapid sequence intubation: a systematic review and economic assessment. Br J Anaesth. Nov. 2010;105(5):568-575.
16. Edoardo DR, Geremia ZM, Giovanni MR, et al. The use of Sugammadex for bariatric surgery: analysis of recovery time from neuromuscular blockade and possible economic impact. Clinicoecon Outcomes Res, 2016;8:317-322.
17. Boon M, Martini C, Broens S, et al. Improved postoperative oxygenation after antagonism of moderate neuromuscular block with Sugammadex versus neostigmine after extubation in "blinded" conditions. Br J Anaesth. Sep. 2016;117(3):410-411.

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