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RESEARCH ARTICLE
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EFFICACY AND SAFETY OF SUGAMMADEX VERSUS NEOSTIGMINE FOR REVERSAL OF NEUROMUSCULAR BLOCKADE IN TOTAL LAPAROSCOPIC HYSTERECTOMY: EXPERIENCE FROM A RESOURCE-LIMITED SETTING.

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ABSTRACT

Background: In many government and teaching hospitals, quantitative neuromuscular monitoring is unavailable, and reversal of neuromuscular blockade (NMB) relies on clinical signs and qualitative peripheral nerve stimulation when possible. Sugammadex offers rapid, predictable reversal of aminosteroid NMB and greater hemodynamic stability while neostigmine remains the conventional agent despite slower onset and suspected residual blockade during recovery. This study compared the clinical efficacy and safety of sugammadex versus neostigmine in total laparoscopic hysterectomy (TLH) patients in a resource-limited setting.

Methods: This observational case series included 50 ASA I–II female patients undergoing TLH under general anesthesia with vecuronium-induced NMB between January 2024 and June 2025 at a tertiary care government hospital. Due to unavailability of quantitative train-of-four monitoring, reversal was initiated at the standardized clinical endpoint of adequate spontaneous ventilation and purposeful movement, with peripheral nerve stimulator assessment when available. Patients received either sugammadex 2 mg/kg IV (n = 25) or neostigmine 50 µg/kg IV with glycopyrrolate 10 µg/kg IV (n = 25). Primary outcome was time from reversal to extubation. Secondary outcomes included hemodynamic stability, postoperative nausea/vomiting (PONV), clinically suspected residual blockade, and PACU readiness.

Results: Sugammadex achieved faster extubation than neostigmine. Hemodynamic stability was greater in the sugammadex group, with fewer episodes of bradycardia and hypotension. PONV and clinically suspected residual blockade were more frequent in the neostigmine group. No major complications occurred in either group.

Conclusion: Even without quantitative monitoring, sugammadex provided faster, more predictable recovery and greater hemodynamic stability compared with neostigmine in total laparoscopic hysterectomy patients. Its judicious use in resource-limited hospitals may enhance safety and efficiency, though cost remains a barrier.

KEYWORDS: Sugammadex, Neostigmine, Neuromuscular Blockade, Total Laparoscopic Hysterectomy, Resource-Limited Setting

INTRODUCTION

Residual neuromuscular blockade (NMB) after surgery is associated with adverse respiratory events and delayed postoperative recovery[1]. In high-resource settings, quantitative train-of-four (TOF) monitoring is recommended to guide reversal, but such technology is often unavailable in government and teaching hospitals, where clinicians must rely on clinical signs or qualitative nerve stimulation.

Neostigmine, combined with an anticholinergic agent such as glycopyrrolate, has long been the standard reversal agent for non-depolarizing NMB, but it has limitations including slower onset, incomplete reversal in deep block, and undesirable cholinergic side effects. Sugammadex, a selective relaxant binding agent, provides rapid and predictable reversal of aminosteroid NMB agents such as vecuronium and rocuronium, without the cholinergic effects of neostigmine[2-4].

Sugammadex, a selective relaxant-binding agent, represents a major pharmacological advance by directly encapsulating aminosteroid neuromuscular blockers such as vecuronium and rocuronium. It provides rapid, reliable reversal without cholinergic adverse effects. Although well established in high-resource environments, its routine use in resource-limited hospitals is constrained by high cost and limited availability.

This study evaluates the efficacy and safety of sugammadex compared with neostigmine for reversal of vecuronium-induced NMB in women undergoing total laparoscopic hysterectomy at a tertiary care government hospital in India.

MATERIALS AND METHODS STUDY DESING AND SETTINGS:

This was a prospective, observational case series conducted at a tertiary care government hospital in Akola, Maharashtra, India, over an 18-month period from January 2024 to June 2025. The study was performed in the Department of Anesthesiology, which routinely manages patients undergoing total laparoscopic hysterectomy (TLH) under general anesthesia with neuromuscular blockade. The hospital functions as both a teaching and referral center, serving a large population in a resource-limited setting where quantitative neuromuscular monitoring is not routinely available.

Inclusion Criteria:

- Female patients, ASA physical status I–II
- Scheduled for elective TLH under general anesthesia
- Age 18–60 years

Exclusion Criteria:

- Known allergy to study drugs
- Significant renal or hepatic dysfunction
- Anticipated difficult airway or high aspiration risk
- Neuromuscular disorders

Sample:

- 50 ASA I–II female patients (18–60 years) undergoing Total Laparoscopic Hysterectomy (TLH) under general anesthesia with vecuronium-induced neuromuscular blockade (NMB).

ANESTHESIA PROTOCOL:

All patients were fasted overnight and premedicated as per institutional protocol. Standard ASA monitoring was used. Anesthesia was induced with propofol (2–2.5 mg/kg) and fentanyl (2 μg/kg), and vecuronium (0.1 mg/kg) was administered for intubation. Anesthesia was maintained with a mixture of oxygen, nitrous oxide, and sevoflurane, with intermittent vecuronium boluses guided by surgical needs and qualitative nerve stimulator assessment when available. Ventilation was controlled with tidal volume 6-8ml/kg, rate adjusted to keep $EtCO_2$ to maintain between35–40 mmHg. Hemodynamic parameters were recorded at 5- minute intervals, and intraoperative fluids

were administered according to surgical needs.

REVERSAL PROTOCOL:

At the conclusion of surgery, reversal was initiated when patients demonstrated adequate spontaneous ventilation (tidal volume ≥ 5 mL/kg), purposeful movement, and eye opening to verbal command, with qualitative TOF response when available. Patients received either:

• Sugammadex group: 2 mg/kg IV bolus
• Neostigmine group: 50 µg/kg IV with glycopyrrolate 10 µg/kg IV

EXTUBATION CRITERIA:

• Adequate tidal volume and minute ventilation.
• Ability to obey verbal commands (eye opening, hand squeeze)
• Strong cough refle on suctioning
• SpO_2 > 95% on FiO_2 40% or less.

OUTCOMES:

• Primary outcome: Time from administration of reversal to successful extubation with adequate spontaneous ventilation and airway reflexes.
• Secondary outcomes: Time to PACU readiness, hemodynamic stability (changes in HR and MAP), incidence of PONV, airway complications, and clinically suspected residual blockade in PACU.

Case No	Age	Sex	Group	Extubation Time (min)	PACU Readiness (min)	MAP Change (mmHg)	PONV	Airway Complication	Residual NMB
1	38	F	Sugammadex	3	8	2	N	N	N
2	39	F	Sugammadex	4	8	3	N	N	N
3	40	F	Sugammadex	3	8	1	N	N	N
4	44	F	Sugammadex	4	9	2	N	N	N
5	42	F	Sugammadex	3	8	2	N	N	N
6	41	F	Sugammadex	4	9	3	N	N	N
7	39	F	Sugammadex	4	8	2	N	N	N
8	38	F	Sugammadex	4	8	1	N	N	N
9	41	F	Sugammadex	4	9	2	Y	N	N
10	42	F	Sugammadex	3	8	2	N	N	N
11	44	F	Sugammadex	3	8	3	N	N	N
12	44	F	Sugammadex	4	9	2	N	N	N
13	43	F	Sugammadex	4	8	1	N	N	N
14	45	F	Sugammadex	3	8	3	N	N	N
15	47	F	Sugammadex	4	8	2	N	N	N
16	45	F	Sugammadex	4	9	2	Y	N	N
17	46	F	Sugammadex	3	8	1	N	N	N
18	53	F	Sugammadex	4	8	2	N	N	N
19	49	F	Sugammadex	4	9	2	N	N	N
20	42	F	Sugammadex	3	8	2	N	N	N
21	46	F	Sugammadex	4	8	3	N	N	N
22	51	F	Sugammadex	4	8	2	N	N	N
23	45	F	Sugammadex	4	8	1	N	N	N
24	50	F	Sugammadex	3	8	2	N	N	N
25	46	F	Sugammadex	3	8	2	N	N	N
26	39	F	Neostigmine	6	18	6	Y	N	Y
27	39	F	Neostigmine	7	18	5	N	N	N
28	45	F	Neostigmine	8	18	7	Y	N	Y

29	44	F	Neostigmine	8	18	6	N	N	N
30	50	F	Neostigmine	9	18	6	Y	N	N
31	48	F	Neostigmine	9	19	7	Y	Y	Y
32	53	F	Neostigmine	9	18	5	N	N	N
33	46	F	Neostigmine	8	18	6	Y	N	Y
34	47	F	Neostigmine	7	18	6	N	N	N
35	50	F	Neostigmine	9	19	7	Y	N	Y
36	42	F	Neostigmine	7	18	6	N	N	N
37	51	F	Neostigmine	9	18	5	N	Y	N
38	49	F	Neostigmine	9	19	8	Y	N	Y
39	46	F	Neostigmine	8	18	6	N	N	N
40	43	F	Neostigmine	7	18	6	Y	N	Y
41	44	F	Neostigmine	8	18	5	N	N	N
42	48	F	Neostigmine	9	19	7	Y	N	Y
43	50	F	Neostigmine	9	18	6	N	Y	N
44	45	F	Neostigmine	9	18	5	N	N	N
45	52	F	Neostigmine	9	19	6	Y	N	Y
46	51	F	Neostigmine	9	18	6	N	N	N
47	47	F	Neostigmine	9	19	7	Y	N	Y
48	52	F	Neostigmine	9	18	6	N	N	N
49	44	F	Neostigmine	8	18	6	Y	N	N
50	48	F	Neostigmine	8	18	7	Y	Y	Y

Key Findings:

- **Extubation Time:**The mean time from administration of reversal to extubation was significantly shorter with sugammadex compared to neostigmine (3.6 ± 0.5 min vs. 8.1 ± 1 min, $p < 0.0001$).
- **PACU Readiness:**Similarly, patients in the sugammadex group achieved earlier readiness for discharge from the PACU (8.2 ± 0.4 min vs. 18.3 ± 0.5 min with neostigmine, $p < 0.0001$).
- Hemodynamics: More stable HR and MAP in the sugammadex group; bradycardia and hypotension occurred more frequently in the neostigmine group.
- Adverse Events: PONV and suspected residual block occurred more often with neostigmine. No major airway complications or serious adverse events were recorded.

DISCUSSION:

This prospective observational study demonstrates that sugammadex provides faster and more reliable reversal of vecuronium-induced neuromuscular blockade compared with neostigmine, even in the absence of quantitative neuromuscular monitoring. Patients who received sugammadex achieved earlier extubation, demonstrated greater hemodynamic stability, and experienced fewer postoperative adverse events such as nausea, vomiting, and suspected residual neuromuscular weakness.

Our findings are consistent with multiple randomized controlled trials conducted in high-resource settings, which confirm the superiority of sugammadex in terms of speed, completeness of reversal, and reduced postoperative complications. Previous studies by Blobner et al.[2], Khuenl-Brady et al.[3], and Fuchs- Buder et al.[4] have similarly shown that sugammadex significantly outperforms neostigmine in recovery profile and safety. Meta-analyses and systematic reviews also report lower rates of pulmonary complications[5-8] and improved recovery when sugammadex is used.

A key advantage observed in our study was the hemodynamic stability associated with sugammadex. Neostigmine, even when co-administered with glycopyrrolate, frequently produced bradycardia and hypotension[1-9], which can complicate emergence from anesthesia. By contrast, sugammadex acts independently of acetylcholine and avoids cholinergic side effects, making it particularly useful in patients with cardiovascular comorbidities.

The relevance of these findings in a resource-limited setting is important. In many government hospitals, lack of quantitative monitoring increases the risk of undetected residual paralysis. By ensuring rapid and complete reversal regardless of monitoring availability, sugammadex provides an additional safety margin. Faster and more predictable recovery also supports operating room efficiency, an important consideration in high-volume public hospitals.

Nevertheless, the study demonstrates that sugammadex can provide clear clinical advantages even in settings with significant resource constraints. Larger randomized trials incorporating cost-effectiveness analyses and ideally supported by affordable quantitative monitoring would help clarify the role of sugammadex in low-resource practice and guide rational adoption policies in government hospitals.

LIMITATIONS:

This study was limited by small sample size, single-center design, lack of randomization, and absence of cost-effectiveness analysis. Additionally, the reliance on clinical signs rather than quantitative monitoring may underestimate residual blockade.

CONCLUSION:

This study demonstrates that sugammadex achieves faster and more predictable recovery from vecuronium- induced neuromuscular blockade compared to neostigmine in women undergoing total laparoscopic hysterectomy, even when quantitative neuromuscular monitoring is not available. The observed benefits included shorter extubation times, fewer episodes of bradycardia and hypotension, lower incidence of postoperative nausea and vomiting, and earlier readiness for PACU discharge. These findings align with international evidence and underscore that the pharmacologic profile of sugammadex offers a clear safety and efficiency advantage over traditional reversal with neostigmine.

In summary, sugammadex represents a significant advance in anesthetic practice, offering rapid, reliable, and safer reversal of neuromuscular blockade compared with neostigmine. Even in resource-limited settings, judicious use of this agent can contribute to improved perioperative outcomes, particularly when applied selectively. The challenge ahead lies in integrating clinical benefits with cost considerations and expanding access to modern monitoring, thereby ensuring that advances in anesthetic pharmacology translate into equitable improvements in patient care.

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