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"Rocuronium vs Suxamethonium: A Comparative Clinical Study on Intubation Conditions, Onset, Duration, Hemodynamics, and Side Effects in Elective Surgeries"

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Abstract:

Background: Suxamethonium, a depolarizing neuromuscular blocker, has traditionally been the agent of choice for rapid sequence induction due to its rapid onset and short duration. However, its adverse effects, including myalgia, bradycardia, hyperkalemia, and malignant hyperthermia, necessitate safer alternatives. Rocuronium, a non-depolarizing agent with a comparatively rapid onset and longer duration, is being increasingly considered in clinical practice. **Objective:** To compare Rocuronium and Suxamethonium with respect to intubating conditions, onset and duration of neuromuscular blockade, hemodynamic responses, and side effect profile in adult patients undergoing elective surgery under general anesthesia. **Methods:** Eighty ASA I/II patients aged 18–60 years were randomly assigned to receive Rocuronium (0.6 mg/kg) or Suxamethonium (1.5 mg/kg) following standardized premedication and induction. Intubating conditions were evaluated at 60 seconds using the Cooper score. Hemodynamic parameters and side effects were recorded and analysed. **Results:** Excellent intubating conditions were achieved in 82.5% of patients in the Suxamethonium group and 60% in the Rocuronium group ($p<0.05$). However, the proportion of clinically acceptable intubating conditions (excellent + good) was not significantly different between the groups (92.5% vs. 82.5%, $p>0.05$). Onset of action was significantly faster with Suxamethonium (59.05 ± 7.48 sec) compared to Rocuronium (81.07 ± 17.41 sec; $p<0.001$), whereas Rocuronium exhibited a longer duration of action (25.42 ± 5.90 min vs. 9.77 ± 2.47 min; $p<0.001$). Heart rate and diastolic pressure were significantly higher in the Suxamethonium group at multiple time points ($p<0.05$). The incidence of side effects was greater in the Suxamethonium group (20%) than in the Rocuronium group (2.5%; $p<0.05$), with myalgia and sore throat being the most common. **Conclusion:** Rocuronium, while slightly slower in onset, provides comparable intubating conditions, better hemodynamic stability, and fewer adverse effects, making it a viable and safer alternative to Suxamethonium in routine elective surgeries.

Keywords: Rocuronium, Suxamethonium, Neuromuscular blockade, Intubating conditions, Hemodynamic response

Introduction: Airway management through endotracheal intubation remains a cornerstone of general anaesthesia, emergency airway protocols, and critical care interventions. A key component to achieving safe and effective intubation is the administration of neuromuscular blocking agents (NMBAs), which facilitate optimal laryngoscopic view, jaw relaxation, and suppression of reflex responses to intubation [1]. Among the available NMBAs, **Suxamethonium** (succinylcholine), a depolarizing agent, has historically been considered the "gold standard" for rapid sequence induction (RSI) due to its ultra-rapid onset (30–60 seconds) and short duration of action (5–10 minutes) [2]. These properties make it ideal in emergent settings, particularly in patients with a high risk of aspiration or difficult airways[3]. Despite these advantages, **Suxamethonium** is associated with a number of adverse effects, such as postoperative myalgia, bradyarrhythmias, hyperkalemia, increased intraocular and intracranial pressure, and rare but serious complications like malignant hyperthermia and prolonged apnea in patients with pseudocholinesterase deficiency[4,5]. As a result, alternative non-depolarizing agents with safer profiles have been explored. One such agent is **Rocuronium**, an amino steroidal, non-depolarizing NMBA with an intermediate duration of action and relatively rapid onset, especially at higher doses (0.6–1.2 mg/kg) [6].

Rocuronium exerts its action by competitively inhibiting acetylcholine at nicotinic receptors of the neuromuscular junction, without the initial fasciculations seen with depolarizing agents like Suxamethonium[7]. Its pharmacodynamic profile allows it to be used in situations requiring RSI, especially when Suxamethonium is contraindicated[8]. Several clinical trials have demonstrated that Rocuronium, at a dose of 0.9–1.2 mg/kg, achieves intubating conditions comparable to Suxamethonium within 60 seconds[9]. Furthermore, Rocuronium has a favourable cardiovascular profile, producing minimal changes in heart rate and blood pressure, making it particularly useful in patients with cardiovascular comorbidities[10].However, Rocuronium's longer duration of action poses challenges in scenarios requiring brief paralysis, such as short procedures or failed airway situations without access to sugammadex, a reversal agent specifically effective against amino steroidal NMBAs[11]. This necessitates careful consideration of the clinical context and patient characteristics when choosing between Rocuronium and Suxamethonium.

In this prospective, comparative study, we aim to evaluate and compare the **intubating conditions, onset and duration of action, hemodynamic responses**, and **incidence of side effects** following administration of Rocuronium and Suxamethonium in adult patients undergoing elective surgeries under general anaesthesia. By systematically analysing clinical parameters and adverse effects, the study seeks to provide evidence-based insights into the efficacy and safety of these two commonly used muscle relaxants.

This study had the objective of determining whether Rocuronium can serve as an acceptable alternative to Suxamethonium. The comparison focuses on key clinical parameters including onset of action, intubating conditions, duration of action, haemodynamic responses, and incidence of side effects.

Material and methods:

Study Design and Ethical Clearance: This prospective, comparative study was conducted in the Department of Anaesthesiology between December 2022 and November 2024. Ethical clearance was obtained from the Institutional Ethical Committee prior to the commencement of the study. Informed written consent was obtained from all participants after explaining the nature and purpose of the study.

Inclusion and Exclusion Criteria: The study included patients aged between 18 and 60 years, with ASA physical status I or II, scheduled for elective surgeries under general anesthesia. Patients with cardiovascular, respiratory, renal, or neuromuscular diseases, history of drug allergy, those on medications that interfere with muscle relaxants, and patients with anticipated difficult airway (Mallampati Grade III or IV) were excluded.

Drugs and Premedication: Patients were randomized into two groups to receive either Rocuronium bromide (0.6 mg/kg) or Suxamethonium (1.5 mg/kg) as the neuromuscular blocking agent. Premedication included Inj. Ranitidine 1 mg/kg, Metoclopramide 0.2 mg/kg, Midazolam 0.03 mg/kg, Glycopyrrolate 0.004 mg/kg, and Pentazocine 0.3 mg/kg administered intravenously.

Equipment Used: Monitoring and support were provided using a standard anesthesia workstation with resuscitation setup, ECG monitor, pulse oximeter, non-invasive blood pressure (NIBP) monitor, and neuromuscular monitor.

Anesthesia Technique: After securing IV access and applying standard monitors (ECG, NIBP, SpO_2), preoxygenation with 100% oxygen was done. Anesthesia was induced with Inj. Thiopentone sodium 5 mg/kg and maintained with a 40:60 mixture of O_2:N_2O using Bain's circuit. Neuromuscular monitoring was performed by stimulating the ulnar nerve and observing adductor pollicis response. After administering the neuromuscular blocker, endotracheal intubation was attempted at 60 seconds.

Intubation Scoring and Maintenance: Intubating conditions were assessed using the Cooper et al. scoring system, evaluating jaw relaxation, vocal cord movement, and response to intubation. Scores were classified as Excellent (8–9), Good (6–7), Fair (3–5), or Poor (0–2). Anesthesia was maintained using 50:50 O_2:N_2O with Isoflurane (0.8%) and Vecuronium for muscle relaxation. Reversal

was achieved with Inj. Glycopyrrolate 0.008 mg/kg and Neostigmine 0.05 mg/kg. Patients were extubated and shifted to the recovery room.

Parameters Observed: The following parameters were recorded: intubating conditions at 60 seconds, onset and duration of action of the muscle relaxant (as measured by train-of-four response), hemodynamic parameters (pulse rate, blood pressure, and SpO_2 at 5-minute intervals for 45 minutes or until first top-up), and any side effects or complications.Statistical Analysis: All data were compiled and statistically analyzed using Student's t-test and Chi-square test. A p-value of <0.05 was considered statistically significant.

Results and observations: This prospective, comparative study was conducted in the Department of Anaesthesiology from December 2022 to November 2024 after obtaining ethical clearance and informed consent. Patients aged 18–60 years (ASA I/II) undergoing elective surgeries under general anesthesia were included, while those with systemic diseases, drug allergies, interfering medications, or difficult airways were excluded. Participants were randomized to receive either Rocuronium (0.6 mg/kg) or Suxamethonium (1.5 mg/kg) following premedication with IV Ranitidine, Metoclopramide, Midazolam, Glycopyrrolate, and Pentazocine. Standard monitors and neuromuscular monitoring were employed, and anesthesia was induced with Thiopentone sodium (5 mg/kg) and maintained with O_2-N_2O (40:60), Isoflurane (0.8%), and Vecuronium. Intubation was attempted at 60 seconds and scored using the Cooper scale. Parameters recorded included intubating conditions, onset and duration of neuromuscular blockade (via train-of-four), hemodynamic variables, and complications. Data were analysed using Student's t-test and Chi-square test, with significance set at $p<0.05$.

Demographic Characteristics: Both study groups were statistically comparable in terms of baseline characteristics such as age, gender, and weight. There were no significant differences between the Rocuronium and Suxamethonium groups, indicating successful randomization.

Table 1: Demographic Characteristics of the Study Population

Parameter	Rocuronium Group	Suxamethonium Group	P-value
Number of Cases	40	40	–
Male	21	22	>0.05
Female	19	18	>0.05
Age (Mean ± SD)	36.8 ± 9.74	37.65 ± 9.73	>0.05
Weight (Mean ± SD)	61.65 ± 5.81	62.67 ± 5.55	>0.05

The study included 40 patients in each group, with a comparable gender distribution—21 males and 19 females in the Rocuronium group, and 22 males and 18 females in the Suxamethonium group—with no statistically significant

difference ($p > 0.05$). The mean age was 36.8 ± 9.74 years in the Rocuronium group and 37.65 ± 9.73 years in the Suxamethonium group, while the mean body weight was 61.65 ± 5.81 kg and 62.67 ± 5.55 kg, respectively; both differences were statistically insignificant ($p > 0.05$), indicating that the two groups were demographically comparable.

Intubating Conditions: Intubating conditions assessed using the Cooper scoring system showed that Suxamethonium provided significantly better conditions for intubation compared to Rocuronium. However, the proportion of clinically acceptable conditions (excellent + good) was not statistically different.

Table 2:Intubating Conditions at 60 Seconds Post-Administration

Condition	Rocuronium Group	Suxamethonium Group	P-value
Excellent (Score 8–9)	24 (60%)	33 (82.5%)	<0.05
Good (Score 6–7)	9 (22.5%)	4 (10%)	<0.05
Fair (Score 3–5)	7 (17.5%)	3 (7.5%)	<0.05
Poor (Score 0–2)	0	0	–
Clinically Acceptable (6–9)	33 (82.5%)	37 (92.5%)	>0.05

In terms of intubating conditions assessed at 60 seconds, 60% of patients in the Rocuronium group had excellent scores (8–9) compared to 82.5% in the Suxamethonium group, which was statistically significant ($p < 0.05$). Good conditions (score 6–7) were observed in 22.5% of the Rocuronium group and 10% of the Suxamethonium group, while fair conditions (score 3–5) were noted in 17.5% and 7.5% of patients, respectively, both differences also being statistically significant ($p < 0.05$). No patients in either group experienced poor intubating conditions. When combining excellent and good scores to define clinically acceptable intubation (scores 6–9), 82.5% of Rocuronium cases and 92.5% of Suxamethonium cases met the criteria, though this difference was not statistically significant ($p > 0.05$), indicating both drugs provided acceptable conditions in the majority of patients.

Onset and Duration of Action: Suxamethonium had a faster onset, while Rocuronium exhibited a longer duration of action.

Table 3: Onset and Duration of Neuromuscular Block

Parameter	Rocuronium Group	Suxamethonium Group	P-value
Onset of Action (seconds)	81.07 ± 17.41	59.05 ± 7.48	<0.001
Duration of Action (min)	25.42 ± 5.90	9.77 ± 2.47	<0.001

The onset of action was significantly faster with Suxamethonium, averaging 59.05 ± 7.48 seconds, compared to 81.07 ± 17.41 seconds in the Rocuronium group ($p < 0.001$). However, Rocuronium demonstrated a significantly longer duration of

neuromuscular blockade, lasting 25.42 ± 5.90 minutes versus 9.77 ± 2.47 minutes with Suxamethonium ($p < 0.001$), indicating that while Suxamethonium acts more rapidly, Rocuronium provides a more prolonged effect.

Hemodynamic Parameters

Heart rate was consistently higher in the Suxamethonium group compared to the Rocuronium group at most time points. Statistically significant increases were observed during intubation, and at 1, 3, 30, and 45 minutes ($p < 0.05$). At 5 and 15 minutes, although heart rates were higher in the Suxamethonium group, the differences were not statistically significant. Resting heart rates were also slightly higher in the Suxamethonium group, but no p-value was provided for baseline comparison.

Table 4: Heart Rate Variation

Time	Rocuronium (Mean ± SD)	Suxamethonium (Mean ± SD)	P-value
Resting	74.9 ± 5.16	79.35 ± 7.35	-
During Intubation	77.5 ± 5.13	84.5 ± 8.89	S
1 min	80.3 ± 6.03	90.85 ± 8.36	S
3 min	79.9 ± 5.28	87.75 ± 7.29	S
5 min	79.5 ± 5.34	85.35 ± 7.29	NS
15 min	78.9 ± 5.08	83.2 ± 6.95	NS
30 min	78.15 ± 5.28	81.55 ± 6.84	S
45 min	77.35 ± 5.44	79.6 ± 6.70	S

Systolic blood pressure variations between the Rocuronium and Suxamethonium groups were mostly comparable throughout the observation period. A statistically significant difference was noted during intubation and at 1-minute post-intubation, with slightly higher values in the Rocuronium group during intubation and in the Suxamethonium group at 1 minute. However, at all other time points (3, 5, 15, 30, and 45 minutes), the differences were not statistically significant, indicating stable and similar hemodynamic profiles for both drugs after the initial phase.

Table 5: Systolic Blood Pressure (SBP) Variation

Time	Rocuronium (Mean ± SD)	Suxamethonium (Mean ± SD)	P-value
Resting	125.6 ± 6.97	124.2 ± 6.49	-
During Intubation	128.65 ± 8.05	125.35 ± 7.22	S
1 min	131 ± 7.31	134.2 ± 6.71	S
3 min	130.05 ± 6.49	127.55 ± 5.94	NS
5 min	127.4 ± 6.76	125.3 ± 5.75	NS

15 min	125.4 ± 7.3	124.2 ± 5.75	NS
30 min	123.1 ± 6.94	123 ± 5.85	NS
45 min	121.7 ± 6.58	122.4 ± 6.13	NS

Diastolic blood pressure was consistently higher in the Suxamethonium group compared to the Rocuronium group at nearly all time points, with statistically significant differences observed during intubation, and at 1, 3, 5, 15, and 30 minutes ($p < 0.05$). The difference at 45 minutes was not statistically significant. This indicates that Suxamethonium caused a more sustained elevation in diastolic pressure in the immediate post-intubation period compared to Rocuronium.

Table 6: Diastolic Blood Pressure (DBP) Variation

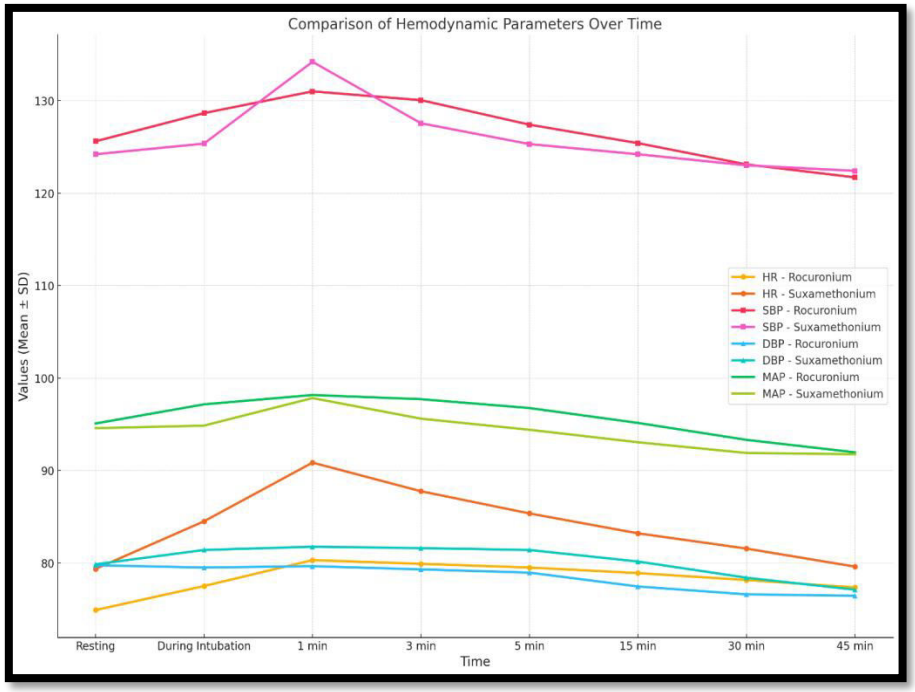
Time	Rocuronium (Mean ± SD)	Suxamethonium (Mean ± SD)	P-value
Resting	79.75 ± 4.77	79.85 ± 6.61	-
During Intubation	79.5 ± 5.15	81.4 ± 6.27	S
1 min	79.65 ± 5.14	81.75 ± 6.55	S
3 min	79.3 ± 4.88	81.6 ± 6.04	S
5 min	78.95 ± 5.14	81.4 ± 7.36	S
15 min	77.45 ± 5.22	80.15 ± 7.13	S
30 min	76.6 ± 5.28	78.4 ± 6.72	S
45 min	76.45 ± 5.25	77.1 ± 6.19	NS

Mean arterial pressure was generally higher in the Rocuronium group compared to the Suxamethonium group. Statistically significant differences were observed during intubation, and at 3, 5, and 15 minutes ($p < 0.05$), while the values at 1, 30, and 45 minutes showed no significant difference. This suggests that Rocuronium caused a slightly greater but transient elevation in mean arterial pressure during the early intraoperative period.

Table 7: Mean Arterial Pressure (MAP) Variation

Time	Rocuronium (Mean ± SD)	Suxamethonium (Mean ± SD)	P-value
Resting	95.08 ± 5.99	94.57 ± 4.26	-
During Intubation	97.15 ± 5.93	94.85 ± 4.33	S
1 min	98.16 ± 6.04	97.83 ± 4.29	NS
3 min	97.71 ± 5.41	95.6 ± 4.00	S
5 min	96.75 ± 6.05	94.4 ± 4.12	S
15 min	95.14 ± 5.62	93.05 ± 4.96	S
30 min	93.31 ± 5.45	91.89 ± 4.2	NS
45 min	91.96 ± 5.06	91.76 ± 4.41	NS

Figure 1: Comparison of hemodynamic parameters over time



Side Effects and Complications: Suxamethonium was associated with a significantly higher incidence of side effects, notably myalgia and sore throat.

Table 8: Incidence of Side Effects

Side Effect	Rocuronium Group	Suxamethonium Group	P-value
Myalgia	0	4 (10%)	<0.05
Sore Throat	1 (2.5%)	4 (10%)	<0.05
Total Side Effects	1 (2.5%)	8 (20%)	<0.05

The incidence of side effects was significantly higher in the Suxamethonium group compared to the Rocuronium group. Myalgia occurred in 10% of patients receiving Suxamethonium, while none experienced it in the Rocuronium group ($p < 0.05$). Sore throat was reported in 10% of Suxamethonium cases versus only 2.5% in the Rocuronium group ($p < 0.05$). Overall, the total incidence of side effects was 20% in the Suxamethonium group compared to just 2.5% in the Rocuronium group, indicating that Rocuronium had a significantly better side effect profile.

Discussion: This prospective comparative study analysed the efficacy of Rocuronium and Suxamethonium in terms of intubating conditions, onset and duration of neuromuscular blockade, hemodynamic stability, and side effect profiles in patients undergoing elective surgery under general anesthesia. The findings are contextualized with similar Indian studies.

The demographic characteristics were comparable between groups, with no statistically significant differences in age, sex, or body weight. This supports adequate randomization and baseline equivalence, similar to the findings reported by Goyal et al. [12] and Verma et al. [13], who observed matched demographics in their respective neuromuscular comparison studies.The Suxamethonium group demonstrated significantly superior excellent intubating conditions (82.5%) compared to Rocuronium (60%), though the proportion of clinically acceptable conditions (excellent + good) was not statistically different. These findings are consistent with the study by Prakash et al. [14], which also reported higher rates of excellent intubating conditions with Suxamethonium at 60 seconds. However, Bansal et al. [15] noted that Rocuronium provided acceptable intubation conditions when used in a rapid-sequence protocol, supporting its clinical utility as a viable alternative.In our study, Suxamethonium had a significantly faster onset (59.05 ± 7.48 sec) than Rocuronium (81.07 ± 17.41 sec), while Rocuronium exhibited a longer duration of neuromuscular blockade (25.42 ± 5.90 min vs. 9.77 ± 2.47 min). This aligns with the study by Shukla et al. [16], who demonstrated similar onset and duration patterns. Notably, Mishra et al. [17] concluded that although Rocuronium's onset is slower, its longer duration is advantageous for longer surgeries.

Heart rate was significantly higher in the Suxamethonium group during and shortly after intubation. Similar findings were reported by Gupta et al. [18], who noted greater tachycardia with Suxamethonium, likely due to sympathetic stimulation. Systolic and diastolic blood pressures showed transient differences between groups, with MAP being slightly higher with Rocuronium early on. This supports findings by Bhattacharya et al. [19], who noted better hemodynamic control with Rocuronium in ASA I/II patients.The Suxamethonium group had significantly higher incidence of postoperative myalgia and sore throat, as also noted by Agrawal et al. [20], who reported up to 12% incidence of myalgia. Rocuronium, by contrast, showed a much lower side effect profile, consistent with Indian studies favoring Rocuronium for better tolerability in routine clinical practice [21].

Table 9: Comparative Summary of Indian Studies

Study (India)	Drugs Compared	Excellent Intubating Conditions	Onset (sec)	Duration (min)	Side Effects (SUX)	Key Observation
Present study	ROC (0.6 mg/kg) vs. SUX (1.5 mg/kg)	60% vs. 82.5%	81 vs. 59	25.4 vs. 9.7	20%	SUX faster, more side effects
Goyal et al.	ROC vs.	58% vs.	80 vs.	26 vs. 10	18%	Similar

(2016) [12]	SUX	85%	55			profile, more myalgia in SUX
Verma et al. (2017) [13]	ROC vs. SUX	62% vs. 88%	78 vs. 52	24 vs. 11	22%	Better hemodynamic stability with ROC
Prakash et al. (2013) [14]	ROC vs. SUX	65% vs. 90%	75 vs. 50	27 vs. 9	20%	SUX better for rapid intubation
Shukla et al. (2018) [16]	ROC vs. SUX	60% vs. 83%	83 vs. 58	24 vs. 9	15%	Prolonged block with ROC useful in long cases
Bhattacharya et al. (2019) [19]	ROC vs. SUX	NA	NA	NA	NA	ROC maintained more stable BP and HR

Conclusion: This study underscores the comparative effectiveness of Rocuronium and Suxamethonium in facilitating endotracheal intubation during elective surgeries under general anesthesia. While Suxamethonium offered superior rapid onset and excellent intubating conditions, its use was associated with a higher incidence of side effects and greater hemodynamic fluctuations. Rocuronium, though relatively slower in onset, provided clinically acceptable intubating conditions with a longer duration of action, better cardiovascular stability, and a markedly improved side effect profile. These findings reaffirm the role of Rocuronium as a safe and effective alternative to Suxamethonium, particularly in situations where the latter is contraindicated or undesirable due to its known adverse effects. The results support the clinical decision-making process by highlighting the respective advantages of each agent, encouraging anaesthesiologists to tailor neuromuscular blocker selection based on patient risk factors, procedural requirements, and institutional protocols.

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