

# Comparison of hemodynamic and neuromuscular properties of rocuronium versus vecuronium in anesthesia

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## Abstract

**Background:** Adequate maintenance of airways in patients undergoing surgeries under general anesthesia was through proper intubation. This was achieved by the extensive usage of neuromuscular blocking drugs, which provided good intubation conditions and relaxation of the muscles. Neuromuscular blockers play a key role in general anesthesia. Rocuronium and vecuronium are used as nondepolarizing muscle relaxants.

**Objective:** To study the neuromuscular properties and cardiovascular effects of rocuronium bromide, the “near-ideal” muscle relaxant and to compare it with vecuronium bromide, an already established drug, during anesthesia.

**Materials and Methods:** This prospective, randomized double-blinded clinical study included 50 patients, 25 patients received 0.6 mg/kg of rocuronium bromide for the maintenance of anesthesia and the other 25 patients received 0.1 mg/kg of vecuronium bromide. The top-up doses administered were 0.15 mg/kg of rocuronium and 0.025 mg/kg of vecuronium.

**Result:** The onset time was significantly shorter in the rocuronium group (Mean  $\pm$  standard deviation [SD] was 108.8 s  $\pm$  28.875 s) compared with vecuronium group (Mean  $\pm$  SD 188.76 s  $\pm$  43.78 s). The duration of action of first dose was significantly longer in rocuronium group (31.5 min) compared with vecuronium group (24.5 min). The duration of action of top-up doses was similar in both the groups ( $p > 0.05$ ). There was no significant difference in any of the haemodynamic variables between the two groups.

**Conclusion:** The duration of action of top-up doses was similar in both the groups ( $p > 0.05$ ). There was no significant difference in any of the hemodynamic variables (heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure) between the two groups.

**KEY WORDS:** Rocuronium, vecuronium, neuromuscular blocking agents, hemodynamics

## Introduction

Neuromuscular blocking agents are firmly entrenched as an integral part of everyday anesthesia practice. The use of muscle relaxants not only revolutionized the practice of anesthesia but also started the modern era of surgery and made

possible the explosive development of cardiothoracic, neurological, and organ transplant surgery. Muscle relaxation is helpful in performing endotracheal intubation and in providing surgical relaxation.

The onset time, duration of muscle relaxation, and the type of surgery are the critical factors in choosing the appropriate muscle relaxant to achieve rapid and successful tracheal intubation.<sup>[1]</sup>

Rocuronium bromide, ORG-9246, a newer nondepolarizing muscle relaxant with quick onset and intermediate duration of action has one-sixth of potency of vecuronium, which was introduced in the 1990s. It is similar in structure and properties to vecuronium but had an added advantage of rapid onset of action and unchanged excretion in urine, thereby, eliminating the side effects of the metabolites. Its introduction is considered as an added advantage over vecuronium.<sup>[2,3]</sup>

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Sehgal et al.<sup>[4]</sup> did a comparable evaluation of intubating conditions, onset of action, and duration of action of rocuronium bromide and vecuronium bromide. They found that rocuronium provides clinically acceptable intubating conditions much earlier than vecuronium.<sup>[4]</sup>

This study was aimed to determine the efficacy of rocuronium, a newer nondepolarizing neuromuscular blocking agent, compared with vecuronium for rapid sequence intubation.

## Materials and Methods

This was a randomized, prospective clinical double-blinded study conducted over a period of 2 years from 2013 to 2015 in the department of anesthesiology at MNR Medical College and Hospital, Sangareddy, Telangana, India. In this study, 100 patients aged between 18 and 55 years belonging to ASA class 1 or 2 (ASA-American Society of Anaesthesiologists) were randomly divided into two groups, each group consisting of 50 patients. Patients were randomized into one of the two groups, group V (vecuronium) and group R (rocuronium) of 50 each for induction and maintenance of anesthesia.

### Inclusion Criteria

1. Patients in age group of 18 to 55 years
2. ASA grade 1 or 2
3. Mallampati class 1 or 2
4. Patients who underwent selected general surgeries, ear, nose, and throat surgeries, gynecological surgeries, orthopedic surgeries, and so on

### Exclusion Criteria

Patients with difficulty in airway (Mallampatti class 3 or 4), gastroesophageal reflux disease, hypertensive patients, allergic to the drugs used, history of cardiovascular or renal disorders, chain smokers, patients with neuromuscular disorders, and pregnant patients were excluded from this study.

Preanesthetic assessment was done the evening before the day of surgery. A detailed history was taken; examination and investigation were reviewed. Informed consent was obtained. Tablet diazepam (5 mg) and tablet ranitidine (150 mg) was given the night before the surgery and 1.5 h before the time of surgery on the morning of the day of the surgery. All the patients were fasting for at least 6 h before surgery.

Before the induction of anesthesia, patients in both groups were premedicated with midazolam 0.025 mg/kg, injection glycopylorate 5 µg/kg, and fentanyl 1 µg/kg. Patients were preoxygenated with oxygen 100% for a period of 3 min followed by the induction of the patients with injection thiopentone 4 mg/kg intravenously. At this point, the train of four stimuli was done and its basal readings noted.<sup>[5]</sup> Four supramaximal stimuli were given before the injection of neuromuscular blockade and followed by every 30 s after the drug has been administered. Each stimulus in the train causes the muscles to contract and fade, and the response provides the basis of evaluation. Patients in group V received vecuronium 0.1 mg/kg and those in group R received rocuronium 0.6 mg/kg.<sup>[6,7]</sup>

Hemodynamic parameters such as systolic blood pressure (BP), diastolic BP, and heart rate were recorded at base line during preoxygenation and at 1, 3, 5, and 10 min after induction. Trachea was intubated using a suitable size portex endotracheal tube. Anesthesia was then maintained with 40% O<sub>2</sub> and 60% N<sub>2</sub>O. After 10 min of an effective tracheal intubation, for every 5 min, train of four stimulations was recorded and the ratio between the first and fourth stimuli was calculated and accordingly muscle relaxants in a maintenance dose of injection vecuronium 0.025 mg/kg and injection rocuronium 0.15 mg/kg was administered and maintained, anesthesia was continued with O<sub>2</sub>, N<sub>2</sub>O, and halothane. During the conduct of anesthesia, patients vital were monitored regularly. Pre extubation, train of four stimuli<sup>[8]</sup> was done and only after appropriate ratio was obtained (>0.7). the patients were administered reversal with injection neostigmine 0.05 mg/kg and injection glycopylorate 5 mg/kg. After appropriate suctioning extubation was done and again a train of four stimuli was done after 3 min and readings were measured.

## Result

The highest age in the study group was 55 years and the lowest age was 18 years. The majority of the patients were in between 31 and 40 years of age (40%) in group V whereas it was between 41 and 50 years (40%) in group R. Only one patient in group V was below 20 years of age. The mean age was 34.64 years in group V whereas it was 37.20 years in group R. The difference in the mean age of the patients between the two groups was not statistically significant ( $p = 0.332$ ).

The study comprised a total of 40 male patients and 60 female patients. Group V comprised 60% (30) male patients and 40% (20) female patients whereas group R comprised 20% (10) male patients and 80% (40) female patients. The result of sex distribution was not statistically significant ( $p = 0.258$ ).

The duration of action between the two groups was that group R had a longer duration of action when compared with vecuronium and it also had a significant  $p$  value of 0.01. The top-up doses also indicated that rocuronium seems to have a prolonged action than Vecuronium (Table 1).

In comparison between the two drugs, there does not seem to be a drastic variation in the heart rate, systolic and

**Table 1:** Duration of action of initial and top-up doses

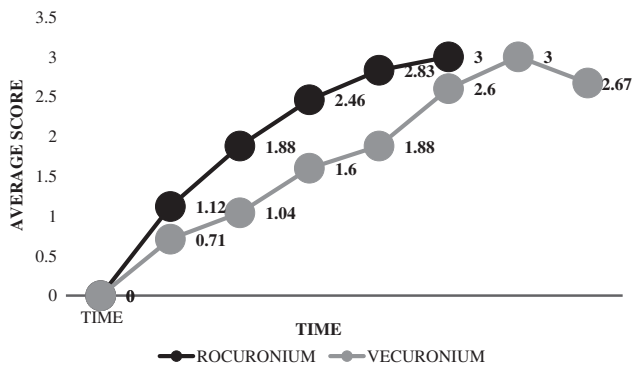
Doses	Group V		Group R	
	Mean (min)	SD	Mean (min)	SD
Initial dose	24.5	7.54	31.5	8.9
First top-up	24.73	5.5	28.48	4.8
Second top-up	24.44	6.6	28.14	5.27
Third top-up	23.50	7.36	28.25	6.8
Fourth top-up	20.50	6.65	31.50	2.12
Fifth top-up	25	—	—	—

V, vecuronium; R, rocuronium; SD, standard deviation.

**Table 2:** Values of hemodynamic responses

Time	Heart rate		Systolic blood pressure		Diastolic blood pressure	
	Group V	Group R	Group V	Group R	Group V	Group R
0	85.84	84.96	128.16	129.04	81.84	84
2	85.52	83.60	131.36	128.48	83.76	85.92
4	83.76	81.96	132.96	129.20	84.48	87.76
6	82.84	81.60	130.88	126.40	82.88	86.40
8	80.64	82.12	128.40	126.72	80.80	83.92
10	78.60	81.44	128.08	125.20	81.44	81.68
15	78.20	79.88	170.28	165.20	81.76	81.52
20	77.84	78.48	125.76	126.16	82.72	81.92
25	79.56	77.16	124.16	128.16	83.04	81.04
30	78.88	80.52	124.24	126.48	82.80	81.68
45	77.88	80.52	125.44	123.28	81.92	82.00
60	77.36	80.40	124.56	122.16	80.72	80.24
75	79.04	79.68	125.28	123.92	80.64	81.04
90	77.80	79.64	124.80	122.96	81.04	80.96
105	79.36	81.24	124.72	123.36	80.96	80.32
120	79.20	80.28	126.16	124.32	80.24	81.92
360	78.80	76.80	124.88	126.88	80.80	82.64

V, vecuronium; R, rocuronium.

**Figure 1:** Time specific changes in Cooper score in two drug groups<sup>[16]</sup>.

diastolic BP, and the respiratory rate. There was only one patient who had a high systolic BP before the induction of anesthesia and which later got optimized after the induction of anesthesia without any antihypertensives (Table 2) (Figure 1).

## Discussion

The mean time for the onset of action was 108.8 s in rocuronium group and it was 188.76 s in vecuronium group, and it was statistically highly significant ( $p < 0.001$ ). The duration of action of initial dose was 31.5 min in rocuronium group and it was 24.5 min in vecuronium group. The duration of action of initial dose was significantly longer in rocuronium group compared with vecuronium group ( $p < 0.01$ ). The duration of action of top-up doses was 25–29 min in rocuronium group

and it was 24–28 min in vecuronium group. The duration of action of each top-up dose was similar in both the groups with no significant difference in  $p$  value.

In this study, in group V, the heart rate at preinduction level was 85.48 beats/min. At the onset of action of vecuronium, the heart rate was 85.52 beats/min. This is correlating with the studies by Booth et al.<sup>[9]</sup> and Schramm et al.<sup>[10]</sup> Robertson et al.<sup>[11]</sup> compared atracurium and vecuronium and found that no significant changes in heart rate were seen after the injection of vecuronium. Wierda et al.<sup>[12]</sup> studied pharmacodynamics of vecuronium in doses up to 0.4 mg/kg and found no adverse hemodynamic effects.

In this study, in group R, the heart rate at preinduction level was 84.96 beats/min. At the onset of action of rocuronium, the heart rate was 83.60 beats/min. The finding of this study is in agreement with the study by Maddineni et al.<sup>[13]</sup> This observation also correlates with the study by Hudson et al.<sup>[14]</sup> with rocuronium in a dose of 0.6 mg/kg wherein they concluded that no changes in heart rate occurred with the given dose of rocuronium. Levy et al.<sup>[15]</sup> studied the heart rate changes with rocuronium in doses ranging from 0.6 mg/kg to 1.2 mg/kg and found no significant changes in heart rate even in high doses.

In group V, the systolic BP at preinduction level was 128.16 mm of Hg. At the onset, BP was 130.52 mm of Hg. The diastolic pressure at preinduction level was 81.84 mm of Hg and it was 81.60 mm of Hg just before the administration of vecuronium. At the onset of action of vecuronium, the diastolic pressure was 82.12 mm of Hg. The finding of this study that vecuronium did not cause any significant change in BP is in accordance with the studies by Wierda et al.<sup>[12]</sup> and Robertson et al.<sup>[11]</sup>

In group R, the systolic BP at preinduction level was 129.04 mm of Hg. At the onset of action of rocuronium, the systolic BP was 128.48 mm of Hg. Throughout the study period, the systolic BP remained between 122.16 mm of Hg and 128.16 mm of Hg. The diastolic pressure at preinduction level was 84 mm of Hg. At the onset of action of rocuronium, the diastolic BP was 85.92 mm of Hg. Throughout the study period, the diastolic BP remained between 80.24 mm of Hg and 86.18 mm of Hg. This correlates with the study by Levy et al.<sup>[15]</sup> who determined the hemodynamics and histamine release of rocuronium when administered in increased doses.

## Conclusion

Rocuronium has a significantly rapid onset of action and intermediate duration of action. It is easily reversible and produces no significant cardiovascular changes. It also has a good safety profile. Therefore, in spite of its high cost and limited availability, rocuronium appears to be a safe drug for rapid sequence intubation when there is no anticipated difficulty in intubation and also in surgeries of prolonged duration without any adverse cardiovascular effects. Cardiovascular effects of muscle relaxant may be produced by muscarinic receptor block, ganglion block, increased noradrenaline release, and blockade of its uptake, or histamine liberation. Neuromuscular blocking agents vary widely with regard to their cardiovascular effects. Among the established agents, tubocurarine, gallamine, and pancuronium exert significant cardiovascular effects; atracurium and mivacurium produce minor changes in cardiovascular variables whereas vecuronium and rocuronium are associated with a high degree of cardiostability.

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