Original Article

Efficacy and Safety of Rocuronium and Vecuronium with Respect to Laryngeal Relaxation and Haemodynamic during General Anaesthesia: A Randomised Controlled Trial

Dr Aditya Kumar Kejriwal[1], Dr Niraj Kumar Mishra[1], Dr Hari Damodar Singh[2], Dr Ganesh Kumar Ram[1], Dr Ajay Kumar[3]

1. Senior Resident, Department of Anaesthesiology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India.
2.. Professor and Head, Department of Anaesthesiology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India.
3. Assistant Professor, Department of Anaesthesiology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, India.

***Corresponding author's E-mail:** mishraniraj3315@gmail.com

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ABSTRACT

Background: For general anaesthesia (GA), a safe and timely endotracheal intubation is essential. The ideal neuromuscular blocking medication for intubation should act fast, have no adverse effects, be short-acting, and result in favourable intubation settings. The main advantage of rocuronium is its rapid onset of action, which facilitates tracheal intubation. The anaesthesiologist must present sufficient evidence in order to decide which course of action is best.

Objective: To examine the hemodynamic parameters and laryngeal relaxation of patients receiving rocuronium versus vecuronium during general anaesthesia.

Materials & Methods: 50 patients in group A received 0.6 mg/kg of rocuronium and 50 patients in group B received 0.1 mg/kg of vecuronium respectively. Before the drugs were administered, and one, five, ten, fifteen, and thirty minutes later, as well as at the end of the surgery, mean arterial pressure (MAP) as well as heart rate were measured. The degree of intubation was assessed using a three-point grading method with respect to the resistance to the laryngoscope blade, amount of coughing, vocal cords relaxation, movement of diaphragm, as well as jaw relaxation.

Results: The rocuronium group achieve more effective intubating conditions as compared to the vecuronium group ($p<0.0001$). The onset of action in rocuronium group (62.25 ± 3.75 seconds) was shown to be significantly faster than that of vecuronium group (138.78 ± 6.67 seconds). After 5 minutes of drug administration, patients in vecuronium group had significantly declined heart rate as compared with rocuronium group ($p<0.05$). The mean arterial pressure was stable in rocuronium group as compared to decline in vecuronium group.

Conclusion: Rocuronium is a better alternative than vecuronium because it acts faster, produces more tolerable intubation conditions with minimal alteration in heart rate and blood pressure, and is less cumulative.

Keywords: Rocuronium, Vecuronium, Heart Rate, Blood Pressure, General Anaesthesia, Endotracheal Intubation.

INTRODUCTION

For general anaesthesia (GA), a safe and timely endotracheal intubation is essential. Muscular relaxation is essential for both providing surgical relaxation and enabling endotracheal intubation. [1-3] The ease of doing endotracheal intubation depends on several factors, including the degree of muscular relaxation, the strength of the anaesthesia, and the expertise of the anaesthesiologist.[2] The length, onset time, and surgical approach of the muscle relaxant must all be carefully taken into account when choosing one to ensure a swift and successful tracheal intubation.[4]

The ideal neuromuscular blocking medication for intubation should act fast, have no adverse effects, be short-acting, and result in favourable intubation settings. For several decades, suxamethonium was the relaxant of choice for fast sequence intubation. However, the unexpected adverse effects such as muscle fasciculation, elevated potassium levels, and a rise in intracranial and intraocular pressure led to a search for more contemporary relaxants.[5]

Two non-depolarizing muscle relaxants that have been marketed as enticing alternatives to succinylcholine are vecuronium and atracurium. However, neither of these drugs had an onset time as short as what was needed for endotracheal intubation.[2] To reduce the amount of time until they started working, different methods were used, such as higher bolus dosages, the priming concept, as well as the timing concept, but at the cost of an extended half-life or sometimes serious adverse reactions. [6] Therefore, the quest for the ideal non-depolarizing medication for quick and safe endotracheal intubation continued even after rocuronium was introduced into clinical practice.

Suxamethonium has become the most widely prescribed and often utilized muscle relaxant for those with an upset stomach or those in need of emergency intubation for nearly 40 years. In addition to fasciculation, bradycardia along with other dysrhythmias, elevated serum potassium, myalgia after surgery, a tendency for prolonged recovery among patients having pseudo-cholinesterase deficit, and the development of malignant hyperthermia are some of the side effects of suxamethonium. Rocuronium, which additionally offers a medium duration of action as well as none of the adverse effects of suxamethonium, satisfies the requirement for a fast-acting medication.[7]

Two strategies that have been used to minimize the therapeutic onset period for non-depolarizing muscle relaxants include large dosages and priming. [8,9] One tactic that has been utilized to quickly establish favourable intubating settings is the "timing principle." When using this technique, a single bolus dose of a muscle relaxant is administered and anaesthesia is induced immediately after manifestation of clinical weakness. [10] This reduces the amount of time that passes between the onset of

anaesthesia and complete muscular relaxation. It may also cause the maximum effect of the IV (intravenous) induction drug and the muscle relaxant to coincide more closely. [11]

The main advantage of rocuronium is its rapid onset of action, which facilitates tracheal intubation. Adults require sixty to ninety seconds to reach appropriate intubation conditions after twice the 95% effective dosage of rocuronium is administered. [12-15] Clinically acceptable intubating conditions are produced faster and with better quality when rocuronium is employed in place of vecuronium or atracurium. Rocuronium 0.6 mg/kg can result in good to excellent intubating conditions in 30 to 60 seconds.[15]

The length, onset time, and surgical approach of the muscle relaxant must be carefully considered when choosing the best one to enable a swift and successful tracheal intubation. The anaesthesiologist must present sufficient evidence in order to decide which course of action is best. Therefore, the purpose of this study was to examine the hemodynamic parameters and laryngeal relaxation of patients receiving rocuronium versus vecuronium during general anaesthesia.

MATERIALS AND METHODS

This was an open label randomised controlled study with parallel 1:1 allocation conducted on patients undergoing surgery under general anaesthesia in Department of Anaesthesiology in tertiary care hospital of eastern India. The study was started after taking approval from institutional ethics committee and written informed consent from patients undergoing surgery under GA as per guidelines of GCP (Good Clinical Practice) and Declaration of Helsinki.

Inclusion Criteria:

- Patients undergoing surgery under GA
- Patients with American Society of Anaesthesiologists (ASA) physical status Grades I and II
- Patients of either gender with age between 18 to 65 years

Exclusion Criteria:

- Patients with any history of hypersensitivity reactions to the anaesthetic drugs or interventional drugs
- Patients having any risk of difficulty during airway intubation
- Patients with pre-existing systemic cardiovascular, respiratory, hepatic, renal, or metabolic disease

50 patients planned for surgery under GA were chosen for each group. Group A received 0.6 mg/kg of rocuronium and group B received 0.1 mg/kg of vecuronium respectively.

Pre-medication for each patient involved an IV infusion of glycopyrrolate at dose of 0.005 mg per kg, midazolam at dose of 1 mg, ondansetron at dose of 4 mg, and ranitidine at dose of 50 mg before to being transferred to the operating room.

Each patient received induction with a 5 mg/kg injection of thiopentone sodium via a suitably sized, cuffed endotracheal tube which was well-lubricated, till the loss of eyelid reflex was achieved. At that point, 1.5 mg per kg of suxamethonium was used for intubation. When the patient started breathing on their own, they were given 0.6 mg per kg of rocuronium or 0.1 mg per kg of vecuronium in group R and group V, respectively.

Nitrous oxide-oxygen was administered to every patient with a ratio of 66:33% using Bain's circuit. Isoflurane was used when needed to maintain deeper degrees of anaesthesia at the recommended dosages of 1% to 3%.

Any residual paralysis was recovered after the surgery by intravenous injection of 0.05 mg/kg of neostigmine and 0.02 mg/kg of glycopyrrolate. As soon as the patients started breathing regularly and on their own again after a thorough oral suctioning treatment, they were extubated. This verified the patient's complete deglutinating reaction, spontaneous eye opening, and regular limb movements. Any unfavourable adverse effects were then noted and the patient was transferred to the postoperative recovery department.

A sphygmomanometer was used to take blood pressure at regular intervals during the surgery, and an ECG and pulse oximetry was used to assess heart rate till completion of the procedure.

Before the drugs were administered, and one, five, ten, fifteen, and thirty minutes later, as well as at the end of the surgery, mean arterial pressure (MAP) as well as heart rate were measured. The degree of intubation was assessed using a three-point grading method that was provided in a good clinical practice guideline for pharmacodynamic research on neuromuscular blocking drugs [16].

The scale had three points:

- Excellent: minimal coughing, minimal diaphragmatic movement, relaxed jaw, immobile vocal cord, and no resistance against the blade
- Good: a relaxed jaw, an intermediate posture, mobile vocal cords, a small amount of diaphragmatic movement (bucking), and a small amount of resistance to the blade
- Poor: clenched jaw, adducted vocal cord, coughing during intubation, and active resistance to the blade.

Statistical Analysis

Data from patients undergoing surgery under GA were collected and entered into Excel 2019, and Graph Pad version 8.4.3 was used to analyse the data. The unpaired student's "t" test was used to test statistical significance of difference in continuous data between the rocuronium and vecuronium groups, such as age, HR, MAP, and mean duration of action. The chi-square test or Fisher's exact test was used to test statistical significance of difference in continuous data between the rocuronium and vecuronium groups such as age group, gender, ASA status, as well as intubation condition. The 95% confidence level for significance of difference between group A and B was set at a p-value of less than 0.05.

OBSERVATIONS AND RESULTS

In either group, 50 patients undergoing surgery under GA were recruited. Both groups were similar age and sex distribution, body weight, and ASA grade (Table 1).

Most of the patients in either rocuronium or vecuronium group belonged to 31-40 years of age and there was slight female preponderance in either group. Most of the patients undergoing surgery under GA were evaluated as ASA grade I. There was no significant difference between group A (rocuronium) and B (vecuronium) with respect to age, gender, and ASA grade ($p>0.05$).

Table 1: Comparison of Baseline Demographic and Clinical Characteristics between Group A (Rocuronium) and Group B (Vecuronium)

Parameters	Group A	Group B	P-Value (Chi-Square Test)
Age			
<30	7	8	0.96
31-40	26	25	
41-50	14	15	
>50	3	2	
Gender			
Male	23	24	0.84
Female	27	26	
ASA Grade			
I	34	36	0.56
II	17	14	

Table 2: Comparison of Intubating Condition between Group A (Rocuronium) and Group B (Vecuronium)

Parameters	Group R	Group V	P-Value
Onset of Action in Seconds (Mean ± SD)	62.25 ± 3.75	138.78 ± 6.67	<0.0001
Duration of Action in Minutes (Mean ± SD)	41.46 ± 4.49	47.30 ± 3.14	<0.0001
Intubation Status (n)			
Excellent	28	13	
Good	17	29	0.01
Poor	5	8	

The rocuronium group achieve more effective intubating conditions as compared to the vecuronium group (p<0.0001). The onset of action in rocuronium group (62.25 ± 3.75 seconds) was shown to be significantly faster than that of vecuronium group (138.78 ± 6.67 seconds).

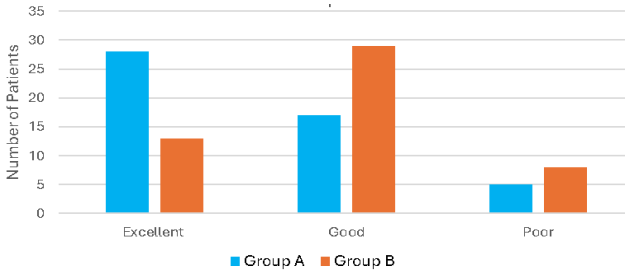

Figure 1: Comparison of Intubating Condition between two Groups

Table 3: Comparison of Heart Rate between Group A (Rocuronium) and Group B (Vecuronium)

Time	Group A	Group B	P-Value (unpaired t-test)
Before Anaesthesia	81.54 ± 9.36	82.66 ± 10.88	0.58
1 Minute	84.75 ± 10.21	82.54 ± 9.77	0.27
5 Minutes	87.90 ± 9.97	81.35 ± 9.84	**0.001**
15 Minutes	83.25 ± 8.26	78.60 ± 8.87	**0.008**

Heart rate was comparable in rocuronium and vecuronium groups before anaesthesia (p>0.05). After 5 minutes of drug administration, patients in vecuronium group had significantly declined heart rate as compared with rocuronium group (p<0.05).

Table 4: Comparison of MAP between Group A (Rocuronium) and Group B (Vecuronium)

Time	Group A	Group B	P-Value (Unpaired t-test)
Before Anaesthesia	97.68 ± 7.34	96.15 ± 8.05	0.32
1 Minute	97.85 ± 7.86	94.65 ± 9.98	0.08
5 Minutes	98.14 ± 5.47	94.16 ± 7.63	**0.003**
15 Minutes	98.80 ± 4.38	95.58 ± 7.85	**0.01**

The mean arterial pressure was stable in rocuronium group as compared to decline in vecuronium group.

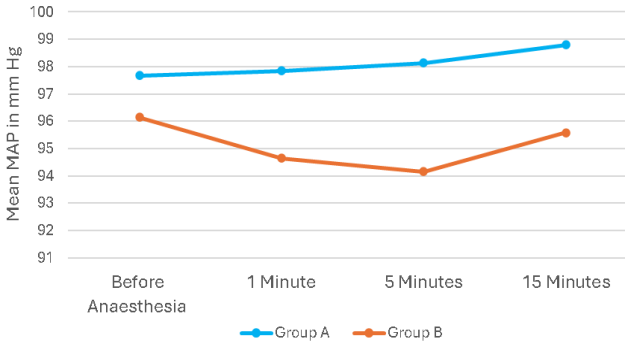

Figure 2: Comparison of MAP between Two Groups

Table 5: Comparison of SBP between Group A (Rocuronium) and Group B (Vecuronium)

Time	Group R	Group V	P-Value (Unpaired t-test)
Before Anaesthesia	125.56 ± 9.35	124.88 ± 9.64	0.72
1 Minute	126.20 ± 9.95	120.62 ± 8.86	**0.004**
5 Minutes	126.62 ± 10.14	119.75 ± 8.95	**0.0005**
15 Minutes	127.44 ± 10.05	120.25 ± 8.60	**0.0002**

Table 6: Comparison of DBP between Group A (Rocuronium) and Group B (Vecuronium)

Time	Group R	Group V	P-Value (Unpaired t-test)
Before Anaesthesia	84.96 ± 5.44	83.08 ± 5.35	0.08
1 Minute	85.28 ± 5.60	81.15 ± 5.38	**0.0002**
5 Minutes	85.95 ± 5.28	79.28 ± 4.72	**<0.0001**
15 Minutes	86.21 ± 4.96	80.40 ± 4.75	**<0.0001**

DISCUSSION

The current randomised controlled study compared the onset of action, intubating conditions, and hemodynamic parameters of 100 patients, aged 18 to 65, scheduled for elective procedures under GA using vecuronium or rocuronium for endotracheal intubation. The present study found that although rocuronium's overall duration of action was marginally shorter than vecuronium's, its early phase of action was similar to vecuronium's.

Robertson EN et al.'s research 17 found that rocuronium created clinically adequate intubating conditions quicker along with fewer side effects than both succinylcholine and vecuronium. The findings of the previously cited studies are consistent with our investigation. W.M. Schramm et al. [18] report that there was no significant change in the MAP while using rocuronium (0.6 mg per kg) or vecuronium (0.1 mg per kg).

Lewy et al. [19] report that at dosages up to 1.2 mg/kg, rocuronium had minimally negative effects on the cardiovascular system among both normal and patients with cardiovascular dysfunction. These results supported the findings of the present investigation. Neeraja Bharti et al. [20] reported that rocuronium exhibited a speedier onset of effect compared to vecuronium due to its faster development of neuromuscular inhibition.

A study by Lin et al. [21] found that the optimal durations of action was 44.2 ± 13.2 mins for the rocuronium arm and 42.5 ± 9.1 mins for the vecuronium arm. The duration of action of rocuronium had been slightly but significantly less than that of vecuronium in the current study. Rocuronium and vecuronium both provided good to outstanding intubating conditions, as reported by Man TT et al. [22] as well as Lin PL et al. [21]. In our research, we also came to the same conclusions.

We found that the rocuronium group saw a significant increase in the heart rate ($P < 0.05$) within one minute or 5 minutes after the drug was administered.

When comparing the vecuronium group to the rocuronium group, there was a substantial drop in the heart rate at 5 and 15 minutes ($p<0.05$). In the rocuronium group, the mean arterial pressure, SBP, and DBP were somewhat steady, while in the vecuronium group, there was a notable fall.

No other issues, such as ischemic changes, ventricular ectopic beats, or rhythm abnormalities, were found in the rocuronium or vecuronium groups during our analysis. No incidences of hypotension were seen. There was no ongoing muscle weakness or residual paralysis in any of the cases that were being studied.

In a 1989 investigation on the hemodynamic consequences of vecuronium, Wierda et al. discovered no connection between the drug and arterial blood pressure at either the systolic or diastolic level or heart rate.[23]

McCoy et al. investigated the cardiovascular consequences of rocuronium or vecuronium during fentanyl anaesthesia. They discovered that whereas rocuronium substantially decreased MAP, it only marginally increased heart rate.[24]

In 1991, Quill et al. looked at the clinical response of rocuronium while under isoflurane anaesthesia.[25] During their analysis, they found that rocuronium caused a slight increase in heart rate with a decrease in MAP, even though the results were not statistically significant.

When Wierda et al. investigated the cardiovascular consequences of rocuronium intubation dosages in 1997, they discovered that while the medication caused a little increase in heart rate, it had no effect on mean arterial pressure (MAP).[26]

Moreover, studies conducted by Sacan et al. have clearly shown that sugammadex, administered IV at a dose of 4 mg/kg, restored residual neuromuscular block with rocuronium more rapidly and efficiently than neostigmine (70 mcg per kg) as well as edrophonium (1 mg per kg).27 In addition, research by Sorgenfrei et al. have shown that at doses of 2.0 mg per kg or greater, sugammadex successfully restored the neuromuscular block generated by 0.6 mg per kg of rocuronium in a dose-dependent way.[28]

One of the limitations of the study is the use of propofol, which could reduce laryngeal reflexes and potentially serve as a confounding factor. More research and larger sample sizes are required to conclusively demonstrate the safety and effectiveness of the drugs used in this study.

CONCLUSION

Rocuronium is a better alternative than vecuronium because it acts faster, produces more tolerable intubation conditions with minimal alteration in heart rate and blood pressure, and is less cumulative. Consequently, rocuronium might wind up being used more often in general anaesthesia in the future. Furthermore, the findings of this research could be utilized in cardiac as well as non-cardiac surgeries involving these muscle relaxants when suxamethonium needs to be avoided because of unfavourable outcomes.

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