e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(3); 744-753

Original Research Article

# Comparative Study of Intubating Condition and Duration of Action After Administration of Rocuronium Bromide and Vecuronium Bromide in Abdominal Surgery using a Train of Four

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**Received: 11-01-2023 / Revised: 14-02-2023 / Accepted: 15-03-2023**
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**Conflict of interest: Nil**

**Abstract**

**Background:** In this study, we wanted to compare vecuronium bromide and rocuronium bromide using TOF on adductor pollicis muscles with regard to the time of onset, conditions of tracheal intubation, and duration of action. We also wanted to compare the hemodynamic parameters in the patients under anaesthesia where either of the drugs was used to produce muscular paralysis.

**Methods:** This was a hospital-based study conducted among 60 patients who presented with various types of elective abdominal surgical procedures to S.C.B. Medical College & Hospital, Cuttack, Odisha from January 2021 to December 2022 for a period of 2 years, after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

**Results:** In a comparison of the meantime for the onset of action between the two groups here, the mean (SD) onset of action in group A (Rocuronium) was 98.60 (7.578) sec and group B (Vecuronium) was 154.80 (20.400) sec, which was statistically highly significant (t value -14.145 and P value 0.000).

**Conclusion:** The advantage of Rocuronium, with its early onset of action, along with good to excellent intubating conditions and cardiovascular stability, makes this neuromuscular relaxant a safe and desirable choice for tracheal intubation in surgical procedures requiring general anaesthesia when there is no anticipated difficulty in intubation.

**Keywords:** Intubating Condition, Rocuronium Bromide, Vecuronium Bromide, Abdominal Surgery, Train of Four.



## Introduction

Modern anaesthesia practice is the administration of "Balanced anaesthesia" which includes amnesia, adequate analgesia, profound muscle relaxation and

the abolition of reflexes, with the maintenance of physiological homeostasis. Rapid and safe endotracheal intubation is an integral part of the administration of anaesthesia during surgical procedures which depend upon the type and degree of muscle relaxation, depth of anaesthesia and skill of an anaesthesiologist. A muscle relaxant is used to facilitate endotracheal intubation and provide surgical relaxation. The ideal neuromuscular blocking agent for intubation should have a rapid onset, brief duration of action, free from hemodynamic changes, be devoid of residual paralysis and provide excellent intubating conditions like a fully relaxed jaw, widely open vocal cord and absence of intubation-response. Before the advent of neuromuscular blocking agents, deep inhalational anaesthesia was required to adequately relax the skeletal muscle which unfortunately induced respiratory and cardiovascular depression. NMBA has made anaesthesia much safer and provides efficient operating conditions by reducing inhalational anaesthetic concentration. In 1942, d-tubocurarine was introduced as a muscle relaxant during surgery. Many non-depolarizing neuromuscular blocking drugs were introduced in the clinical practice after this, but they had many side effects like cardiovascular instability, the occurrence of recurarization and residual paralysis and were not suitable for use in certain clinical situations. Succinylcholine, which is a depolarizing muscle relaxant (1952), has a rapid onset of action and useful gold standard muscle relaxant for rapid sequence intubation. However, it has several unintended side-effects such as muscle fasciculations, thereby producing postoperative myalgia, hyperkalemia, bradycardia, dysrhythmias, rise in intraocular, intragastric, intracranial pressure, incidences of prolonged recovery in patients with different associated deficiencies and diseases and it also triggers malignant hyperthermia. This led to the search for newer relaxants alternative to succinylcholine with the same or similar parameters like early onset time, and excellent intubating conditions but without the side effects of succinylcholine. Vecuronium bromide and Atracurium besylate were introduced nearly simultaneously in 1981. Atracurium is a benzylisoquinoline structure and Vecuronium is a mono-quaternary analogue of steroid relaxant pancuronium. Both are intermediate-acting NDMRs; provide a faster onset, rapid and measurable recovery with little dependence on the kidneys for elimination and great hemodynamic stability. But neither of these agents has been demonstrated to have a significantly shorter onset time as needed for rapid tracheal intubation. Then work is carried out by various workers to confirm that a rapid onset of action can be produced by compounds of relatively low potency. This concept led to the development of rocuronium. Rocuronium Bromide (the 1990s), intermediate-acting aminosteroid NMDR, chemically 2-morphine, 3-diacetyl, 16-N- allylpyrollidone derivative of Vecuronium, is five to seven times less potent than Vecuronium. It is cardio-stable and has a rapid onset of action, which would render it the muscle relaxant of choice for the facilitation of both routine and crash intubations. Its introduction is considered an added advantage over Vecuronium. Intubating conditions and duration of action can be assessed clinically or by "Neuromuscular monitoring" which is the best non-invasive technique. In clinical practice, neuromuscular blockers are monitored by assessing the response of muscles by stimulating a particular nerve and observing the Train of Four with a neuromuscular monitor. It provides ideal operating conditions with optimal doses of muscle relaxants and helps to minimize side effects like unwanted movements, prolonged paralysis and delayed recovery. Several clinical studies conducted in the past have confirmed rocuronium's brief onset time. However, most of these studies

have compared the onset time and intubating conditions of rocuronium with succinylcholine. Arun Sehgal (2001) [1] did a comparative evaluation of intubating conditions, onset of action and duration of action of rocuronium bromide and vecuronium bromide.

### Aims and Objectives

- To compare the time of onset, conditions of tracheal intubation, and duration of action - between two non-depolarizing muscle relaxants: Vecuronium bromide and Rocuronium bromide using TOF on adductor pollicis muscles.
- To compare hemodynamic parameters in patients under anaesthesia where either of the drugs is used to produce muscular paralysis.

### Methods

This was a hospital-based study conducted among 60 patients who presented with various types of elective abdominal surgical procedures to S.C.B. Medical College & Hospital, Cuttack, Odisha from January 2021 to December 2022 for a period of 2 years, after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

### Inclusion Criteria

- Pts. with ASA physical status Class-I and II.
- Age-15- 60 years, Mallampati - I & II.

### Exclusion Criteria

- Hepatic, renal or neuromuscular disease.
- Asthma, COPD, heavy smoker.
- Cardiovascular disease, hypertensive patients.
- H/O or Anticipated difficult intubation (e.g. obesity).
- Pregnancy, Mallampati III or IV and thyromental distance < 6 cm).
- H/o known allergy to drugs under study.
- Those taking anticonvulsants, aminoglycosides or any.
- Other medications may affect the action of NDMRs.

60 patients of either sex aged 15-60 years of ASA physical status I & II were selected for the study.

Gr-A:-(30 patients): Intubating dose of rocuronium 0.6mg/kg IV.

Gr-B: (30 patients): Intubating dose of vecuronium 0.1mg/kg IV.

The purpose and procedure of the study were explained to all patients and informed consent for anaesthesia and the procedure was obtained. The patients were randomly allocated into 2 groups of 30 patients each to receive an intubating dose of one of the drugs chosen for the study. Drug selection for the patients was done on a lottery basis.

### Statistical Methods

The observed results were analysed statistically using the chi-square test for qualitative data & student's t-test for quantitative data. Intergroup comparison was made using the unpaired t-test and intragroup comparison was made using paired t-test. Microsoft Excel was used for the analysis of the data. Microsoft word and Microsoft excel were used to generate tables. The inferences based on the p-value were made as follows - $P>0.05$ – Not significant, $P<0.05$ – Significant, $P<0.01$ – Highly significant.

### Results

**Table 1: Comparison of the meantime for the onset of action between two groups**

| Groups | Time for onset of action(sec) Mean±SD | t value | p-value |
|---|---|---|---|
| **Rocuronium (gr a)** | 98.60±7.578 | -14.145 | 0.000 |
| **Vecuronium (gr b)** | 154.80± 20.400 | | |

The mean (SD) onset of action in group A (Rocuronium) was 98.60 (7.578) sec and group B (Vecuronium) was 154.80 (20.400) sec, which was statistically highly significant (t value -14.145 and P value 0.000).

**Table 2: Comparison of mean duration of action of maintenance dose between two groups**

| Group | Duration of action of intubating dose(min) Mean±SD | t value | p-value |
|---|---|---|---|
| Rocuronium (group a) | 30.17± 5.497 | -1.843 | 0.070 |
| Vecuronium (group b) | 32.90±5.979 | | |
| **Comparison of mean duration of action of intubating dose between two groups** | | | |
| **Group** | **Duration of action of maintenance dose(min) Mean±SD** | **t value** | **p-value** |
| Rocuronium (group a) | 21.33±3.651 | -1.545 | 0.128 |
| Vecuronium (group b) | 22.93±4.339 | | |

The mean duration of action of intubating dose of the two groups. The mean (SD) duration of action of intubating dose in group A (Rocuronium) was 30.17±5.497 min, group B(Vecuronium) was 32.90±5.979 minutes and the difference was not statistically significant (t= -1.843, P=0.070).

The mean duration of action of maintenance dose between two groups. The mean (SD) duration of action of maintenance dose in group A (Rocuronium) was 21.33(3.651) minutes and group B (Vecuronium) was 22.93(4.339) minutes and the difference was not statistically significant (t= -1.545, P=0.128).

**Table 3: Comparison of mean systolic blood pressure between two groups at various intervals**

| Group | No. of cases | Pulse rate mean (SD) [bpm] | | | | |
|---|---|---|---|---|---|---|
| | | Pre-op | Post intubation | | | |
| | | | 1min | 5 min | 10 min | 15 min |
| rocuronium | | 76.53 (6.410) | 88.33 (5.333) | 86.20 (5.542) | 81.50 (5.469) | 76.80 (6.071) |
| vecuronium | | 75.53 (4.890) | 88.20 (4.310) | 85.80 (4.310) | 81.07 (4.863) | 76.40 (5.468) |
| t value | | 0.679 | 0.107 | 0.312 | 0.324 | 0.268 |
| p-value | | 0.500 | 0.916 | 0.756 | 0.747 | 0.790 |
| **Comparison of mean pulse rate between two groups at various intervals** | | | | | | |
| **Group** | **No. of cases** | **Pre-op systolic blood pressure (mmHg)** | **Post-intubation systolic blood pressure (mmHg)** | | | |
| | | | **1min** | **5 min** | **10 min** | **15 min** |
| (rocuronium) | 30 | 121.13 (8.673) | 130.40 (8.669) | 128.07 (8.702) | 124.40 (8.377) | 120.47 (7.820) |
| (vecuronium) | 30 | 120.60 (8.807) | 131.73 (9.108) | 129.67 (9.189) | 125.20 (8.640) | 121.20 (8.892) |
| t value | | 0.236 | -0.518 | -0.692 | -0.364 | -0.339 |
| p-value | | 0.814 | 0.564 | 0.491 | 0.717 | 0.736 |

The comparison of mean pulse rate between two groups at various intervals. The mean (SD) pre-operative pulse rate was 76.53(6.410) beats per minute and 75.53(4.890) beats per minute in group A (Rocuronium) and group B (Vecuronium) respectively. It was comparable in both the groups and statistically not significant (t=0.679, P=0.500). There was no significant difference in the mean pulse rate between the two groups at various time intervals after intubation after 1 min (P=0.916), 5 min (P=0.756), 10 min (P=0.747), and 15 min (P=0.790).

In each group, slight increase in pulse rate was noted which was maximum at 1 minute after intubation and came to the baseline within 15 minutes after intubation.

The comparison of mean systolic blood pressure between two groups at various intervals.

The mean (SD) pre-operative blood pressure was 121.13(8.673) mmHg and 120.60(8.807) mmHg in group A (Rocuronium) and group B (Vecuronium) respectively. It was comparable in both groups and statistically not significant (t=0.236, P=0.814). There was no significant difference in the mean systolic blood pressure between the two groups at various time intervals after intubation after 1 min (P= 0.564), 5 min (P= 0.491), 10 min(P=0.717) and 15min (P=0.736). In each group, slight increase in pulse rate was noted which was maximum at 1 minute after intubation and came to the baseline within 15 min after intubation.

**Table 4: Comparison of mean diastolic blood pressure between two groups at various intervals**

| Group | No. of cases | Pre-op diastolic blood pressure (mmHg) | Post intubation diastolic blood pressure (mmHg) | | | |
|---|---|---|---|---|---|---|
| | | | 1min | 5 min | 10 min | 15 min |
| (Rocuronium) | 30 | 78.07 (4.502) | 81.27 (5.930) | 80.60 (6.262) | 76.53 (4.329) | 76.27 (3.850) |
| (Vecuronium) | 30 | 78.00 (4.698) | 82.20 (5.690) | 80.60 (5.685) | 78.07 (5.265) | 77.13 (4.091) |
| t value | | 0.056 | -0.622 | 0.000 | -1.232 | -0.845 |
| p-value | | 0.955 | 0.536 | 1.00 | 0.223 | 0.402 |

The comparison of mean diastolic blood pressure between two groups at various intervals. The mean (SD) pre-operative diastolic blood pressure was 78.07(4.502) mmHg and 78.00(4.698) in group A (Rocuronium) and group B (Vecuronium) respectively. It was comparable in both groups and statistically not significant (t=0.056, P=0.955). There was no significant difference in the mean pulse rate between the two groups at various time intervals after intubation like after 1 min (P=0.536), 5 min (1.00), 10 min (0.223), and 15 min (0.402). In each group, slight increase in diastolic blood pressure was noted which was maximum at 1 minute after intubation and came to the baseline within 10-15 minutes after intubation.

## Discussion

Group A (patients who received Rocuronium as the muscle relaxant for intubation and maintenance of muscle relaxation) and Group B (patients who received Vecuronium as the muscle relaxant for intubation and maintenance of muscle relaxation).

NMBA has made anaesthesia much safer and provides efficient operating conditions. It is used to facilitate endotracheal intubation and provides surgical relaxation.

Rocuronium possesses most of these properties of an "ideal" muscle relaxant except the high potency. It is similar in structure and properties to Vecuronium but has the added advantage of rapid onset of action and unchanged excretion in urine thereby eliminating the side effects of the metabolites. So, its introduction is considered an added advantage over Vecuronium. Moreover, as it has the specific antidote (Sugamadex), "Switch on and switch off" type of muscle relaxation is possible and `Recurarisation' is prevented.

So, the present study was undertaken to study the neuromuscular properties and cardiovascular effects of Rocuronium, the 'near-ideal' muscle relaxant and compare it with Vecuronium.

There have been studies conducted with various doses of these two muscle relaxants for comparison. Rocuronium in a dose of 0.6 mg/kg and Vecuronium in a dose of 0.1 mg/kg which are twice their ED95 doses were commonly used for intubation purposes. As for intubation usually, twice the ED95 dose of an NDMR is required. In the present study, we used 2ED95 doses i.e. Rocuronium in the dose of 0.6 mg/kg and compared it with Vecuronium in the dose of 0.1 mg/kg as intubating dose. Many other workers like Booth M G et al, [2] Scheiber G et al, [3] Lin PL et al, [4] Smith I et al, [5] Sathe Viswas, [6] Patel DD et al [7] and Somani et al [8] have also used 2ED95 dose of Rocuronium and Vecuronium in their studies. Study by Parasa M et al. [9] using 3ED95 doses of both drugs were associated with a longer duration of action and this may be inappropriate in many clinical situations.

Sathe Viswas Patel DD et al and Somani et al have compared the neuromuscular effects of these two drugs in patients receiving thiopental as an induction agent. In our present study, we also used thiopental as an induction agent.

In our study, we used neuromuscular monitoring by Train of four because the response of neuromuscular blocking drugs was not predictable in all patients, so the monitoring of neuromuscular function provided a more predictable and rational approach to the use of muscle relaxants and better and faster recovery of the patients by optimizing the doses, hence providing better patient care.

Among all patterns of stimuli in neuromuscular monitoring, train-of-four is the more convenient and popular method for assessment of neuromuscular transmission as it not only causes significantly less discomfort to the patient than tetanic stimuli but in addition has a more sensitive index of receptor blockade compared to single twitch stimuli. Due to its relatively lower frequency, it allows response to be evaluated manually or visibly.

In our study, adequate abdominal relaxation was required which was better with adductor pollicis monitoring. The ulnar nerve at the wrist (as most commonly used site for nerve stimulation) and the response at the adductor pollicis were observed and recorded in my study because the adductor pollicis muscle has been promoted as the most useful clinical tool and is the gold standard because of its easy accessibility for visual and tactile assessment. The adductor pollicis muscle exhibits different sensitivity and time course from the laryngeal muscles. But according to Suresh S.N. and Singh NG [10] (2010), monitoring of neuromuscular activity of the Adductor Pollicis using a Train of Four to determine the appropriate tracheal intubation time and condition is clinically more relevant than monitoring the Orbicularis Oculi muscle.

Our study assessed the neuromuscular blockade visually because it is non-invasive and more relevant in clinical practice. Although mechanomyography, electromyography have been used in some

of the studies conducted in the past (Xue et al, [11] Tullock et al [12] but this equipment is bulky, difficult to operate and feasible to accommodate in O.T set up is `Nil'.

**Demographic profile of patients**

The demographic table showed the distribution of patients according to age, body weight and sex.

The mean age in the Rocuronium group (group A) was 34.83(8.66) years, and Vecuronium group (group B) was 35.13(9.54) years and there was no statistically significant difference between the two groups in the age (P= 0.899).

The mean weight in the Rocuronium group (group A) was 52.87(4.94) kg, and Vecuronium group (group B) was 52.77(5.51) kg and no statistically significant difference in the body weight between the two groups (p= 0.941). There was no statistically significant difference in both groups with respect to sex, with a P value of 0.796. Thus, the two groups were similar in terms of age, weight and sex distribution.

**Types of operation**

The different types of elective operative procedures conducted in the two groups were comparable. The majority of surgical procedures undertaken were upper abdominal and few were lower abdominal in both groups and profound relaxation was required in all cases.

**The onset of action and intubating condition**

**Onset of action**

In the present study, the onset of action was considered as the time taken from the injection of muscle relaxant to the abolition of all four responses to train of four stimuli.

In the present study, the mean (SD) time for onset of action for group A (Rocuronium group) was 98.60(7.578) sec and group B (Vecuronium group) was 154.80(20.400) sec and the onset of action in group A (Rocuronium) was rapid compared to group B (Vecuronium) with high statistical significance ($p<0.001$).

The present study concurs with the findings of the studies of Magorian T et al, [13] Sathe V et al, and Somani M et al who have also reported an onset time similar to our present study. All the previous studies showed that the time for onset of action of Rocuronium was faster than Vecuronium with a high statistical significance which is similar to our result.

**Intubating condition**

Intubating conditions were either excellent or good in both groups in our study. Intubating conditions with Rocuronium were excellent in 86.67% and good in 13.33% of patients while in the Vecuronium group, intubating conditions were excellent in 80% and good in 20% of patients, which were comparable and without statistically significant difference.

Lee HK et al [14] (2009), Suresh SN and Singh NG (2010) found excellent intubating conditions of Rocuronium in 87%, and 87.5% respectively in adductor pollicis muscle by using TOF. Our study finding coincides with their results.

A study by Somani et al. with 2ED95 of Rocuronium and Vecuronium using a TOF guard monitor at AP showed a significantly early onset of action in the Rocuronium group without significant difference in intubation scores. A study by Sathe V et al also found that Rocuronium produced excellent and good intubating conditions much earlier than Vecuronium and our study shows a similar result as these two studies.

The Rocuronium provides clinically excellent or good intubating conditions much earlier than vecuronium. The reason for this rapid onset of the neuromuscular block has been suggested to be the low potency of Rocuronium, entailing the

presence of more relaxant molecules in the bloodstream which results in a large concentration gradient towards the biophase at pre and post-synaptic receptor sites at the neuromuscular junction. Another possible explanation is that the plasma protein binding of Rocuronium is less than vecuronium.

**Duration of action**

The duration of action of the intubating dose in our study was considered as the time from injection of muscle relaxant to the recovery of the first twitch in the train of four and maintenance doses were supplemented at the recovery of the first twitch in the train of four.

The mean (SD) duration of action of intubating dose in group A (Rocuronium) was 30.17±5.497 min, group B (Vecuronium) was 32.90±5.979 minutes, and the difference was not statistically significant(P>0.05).

The duration of action of an intubating dose of Rocuronium in our study correlates with the findings of Cooper R et al, [15] Mirakhur RK, [16] Wierda et al, [17] Van den Broek, [18] Shukla A et al [19] and Patel et al.

The duration of action of an intubating dose of Vecuronium in our study correlates with the findings of Russo R et al, [20] Wierda et al, Van den Broek L and Patel et al.

In our study, there was no significant variation in the duration of action between the two groups. Such statistical correlation was also found in previous studies like Booth MG et al, Magorian T et al, Robertson EN, and Patel DD et al.

In our study, the mean (SD) duration of action of maintenance dose in group A (Rocuronium) was 21.33(3.651) minutes, group B (Vecuronium) was 22.93(4.339) minutes and the difference was not statistically significant. The mean duration of intubating dose was longer than the maintenance dose because the intubating dose was larger than the maintenance dose and supplemented by analgesic and thiopentone.

**Hemodynamic changes**

In our study, the mean (SD) pre-op pulse rate was 76.53(6.410) per minute and 75.53(4.890) per minute in the Rocuronium and Vecuronium groups respectively which were statistically not significant.

In Rocuronium and Vecuronium groups, the mean (SD) pre-op systolic blood pressure was 121.13(8.673) mmHg and 120.60(8.807) mmHg respectively and the diastolic pressure was 78.07(4.502) mmHg and 78.00(4.698) mmHg respectively which were comparable in both the groups (P > 0.05).

The changes in heart rate and systolic or diastolic blood pressure at the different time intervals after intubation were also similar in both groups and had no significant difference (P > 0.05).

This finding is in accordance with the studies of Nitschmann P et al, [21] Sathe V et al, Lee H et al, [22] Patel DD et al, and Dwivedi MB et al [23] who have all found no difference in any of the hemodynamic variables between the two groups during comparison.

But in our study, within each group, there was a significant rise in pulse rate, systolic blood pressure and diastolic blood pressure 1 minute after intubation as compared to baseline which might be due to the stress response of intubation which slowly returns to baseline within 10-15 minutes in both the groups.

Sathe V et al and Patel DD et al also found similar trends of hemodynamic changes at different time intervals. In view of the above findings of hemodynamic parameters, in the present study, it was noted that both drugs offered good cardiovascular stability.

## Adverse effects

No adverse effects like bronchospasm, hypotension or rashes were observed in any patient with either drug during the study.

## Conclusion

Rocuronium has a more rapid onset of action and provides excellent and good intubating conditions more rapidly than Vecuronium. Both drugs have similar cardiovascular stability and intermediate duration of action without any adverse effects. Thus, the advantage of Rocuronium, with its early onset of action, along with good to excellent intubating conditions and cardiovascular stability, makes this neuromuscular relaxant a safe and desirable choice for tracheal intubation in surgical procedures requiring general anaesthesia when there is no anticipated difficulty in intubation.

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