

COMPARISON OF ROCURONIUM BROMIDE AND SUCCINYLMCHOLINE CHLORIDE FOR USE DURING RAPID SEQUENCE INTUBATION IN ADULTSCh. Penchalaiah¹, N. Jagadeesh Babu², T. Kumar³**HOW TO CITE THIS ARTICLE:**

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ABSTRACT: BACKGROUND AND OBJECTIVE: The goal of rapid sequence intubation is to secure the patients airway smoothly and quickly, minimizing the chances of regurgitation and aspiration of gastric contents. Traditionally succinylcholine chloride has been the neuromuscular blocking drug of choice for use in rapid sequence intubation because of its rapid onset of action and profound relaxation. Succinylcholine chloride remains unsurpassed in providing ideal intubating conditions. However the use of succinylcholine chloride is associated with many side effects like muscle pain, bradycardia, hyperkalaemia and rise in intragastric and intraocular pressure. Rocuronium bromide is the only drug currently available which has the rapidity of onset of action like succinylcholine chloride. Hence the present study was undertaken to compare rocuronium bromide with succinylcholine chloride for use during rapid sequence intubation in adult patients. **METHODOLOGY:** The study population consisted of 90 patients aged between 18-60 years posted for various elective surgeries requiring general anaesthesia. Study population was randomly divided into 3 groups with 30 patients in each sub group. 1. Group I: Intubated with 1 mg kg⁻¹ of succinylcholine chloride (n=30). 2. Group II: Intubated with rocuronium bromide 0.6 mg kg⁻¹ (n=30). 3. Group III: Intubated with rocuronium bromide 0.9 mg kg⁻¹ (n=30). Intubating conditions were assessed at 60 seconds based on the scale adopted by Toni Magorian et al. 1993. The haemodynamic parameters in the present study were compared using p-value obtained from student t-test. **RESULTS:** It was noted that succinylcholine chloride 1 mg kg⁻¹ body weight produced excellent intubating conditions in all patients. Rocuronium bromide 0.6 mg kg⁻¹ body weight produced excellent intubating conditions in 53.33% of patients but produced good to excellent intubating conditions in 96.67% of patients. Rocuronium bromide 0.9 mg kg⁻¹ body weight produced excellent intubating conditions in 96.67% of patients, which was comparable to that of succinylcholine chloride. Thus increasing the dose of rocuronium bromide increased the number of excellent intubating conditions but at the cost of increased duration of action. **INTERPETATION AND CONCLUSION:** Thus, from the present study, it is clear that succinylcholine chloride is the drug of choice for rapid sequence intubation. Rocuronium bromide is a safe alternative to succinylcholine chloride in conditions where succinylcholine chloride is contraindicated and in whom there is no anticipated difficult airway.

KEYWORDS: Anaesthesia; Rapid sequence intubation; Succinylcholine chloride; Rocuronium bromide.

INTRODUCTION: With the introduction of endotracheal anaesthesia during World War I and balanced anaesthesia in 1926, a search began for a drug which could cause jaw relaxation to

ORIGINAL ARTICLE

facilitate endotracheal intubation. Most of the intubations were done with inhalational technique which was associated with problems like laryngospasm, bronchospasm.

Further there was a need to take the patient sufficiently deep before intubation which lead to haemodynamic disturbances.¹ The first skeletal muscle relaxant d-tubocurarine which was non-depolarizing in nature was introduced in 1942 to fulfill the need for jaw relaxation. Though this drug provided excellent muscle relaxation, it had additional ganglion blocking properties causing tachycardia, hypotension even in clinical doses. Further it had a delayed onset at jaw, making it unsuitable for use during rapid sequence intubation in emergency cases.

Hence a search began for a relaxant which had a rapid onset and short duration of action.² Succinylcholine chloride, introduced in 1951, was a synthetic depolarizing muscle relaxant. It fulfilled both of the above requirements, and soon became the drug of choice for endotracheal intubation especially in rapid sequence intubation in emergency cases.

But all did not go well for succinylcholine chloride when its adverse effects started surfacing especially hyperkalemia, rise in intragastric, intraocular, intracranial pressures and cardiovascular effects. Thus the quest began for a safer substitute for succinylcholine chloride.

The aim of research on neuromuscular drugs was to have non depolarising muscle relaxant, which is like succinylcholine chloride without its side effects. Though many Non Depolarising Muscle Relaxant drugs like atracurium besylate, vecuronium bromide and mivacurium chloride were introduced, none of them could challenge succinylcholine chloride in terms of its onset. The new Non Depolarising Muscle Relaxant drug rocuronium bromide introduced in 1994 became the first competitor for succinylcholine chloride. Rocuronium bromide when given in two to three times the ED₉₅ dose is said to produce excellent to good intubating conditions in 60 seconds. Further rocuronium bromide is said to be devoid of the adverse effects that are seen with succinylcholine chloride. Hence, the present study was undertaken to evaluate the intubating conditions with rocuronium bromide 0.6 mg kg⁻¹ and 0.9 mg kg⁻¹ body weight and to compare the intubating conditions with that of succinylcholine chloride 1mg kg⁻¹ body weight, for use during rapid sequence intubation of anaesthesia in adult patients.

OBJECTIVES OF THE STUDY:

- A. To compare the intubating conditions of rocuronium bromide 0.6mg kg⁻¹, 0.9mg kg⁻¹ body weight with that of succinylcholine chloride 1 mg kg⁻¹ body weight at 60 seconds.
- B. To study the clinical duration of action of rocuronium bromide 0.6mg kg⁻¹, 0.9mg kg⁻¹ body weight and succinylcholine chloride 1 mg kg⁻¹ body weight.
- C. To study the cardiovascular responses associated with the administration of rocuronium bromide and succinylcholine chloride.
- D. To study the side effects associated with the use of rocuronium bromide.

METHODOLOGY: A clinical study comparing rocuronium bromide 0.6mg kg⁻¹ and 0.9mg kg⁻¹ with succinylcholine chloride 1 mg kg⁻¹ for use during rapid sequence intubation of anaesthesia.

The study population consisted of 90 adult patients of ASA grade I and II belonging to both sexes in the age group of 18 to 60 years who were posted for various elective surgeries.

ORIGINAL ARTICLE

Informed consent was obtained from the patients before taking up for surgery. Exclusion criteria consisted of patients with hypertension, diabetes, bronchial asthma, ischaemic heart disease or anticipated difficult airway.

The study population was randomly divided into three groups with 30 patients in each group.

Group I consisting of 30 patients was to receive succinylcholine chloride 1mg kg⁻¹ body weight and intubation attempted at 60 seconds.

Group II consisting of 30 patients were to receive rocuronium bromide 0.6mg kg⁻¹ body weight and intubation attempted at 60 seconds.

Group III consisting of 30 patients were to receive rocuronium bromide 0.9mg kg⁻¹ body weight and intubation attempted at 60 seconds.

A thorough pre anaesthetic evaluation was done a day before surgery and all the necessary investigations were done to rule out any systemic disease. Tab alprazolam 0.5mg and tab pantoprazole 40mg were administered to all patients on the night before surgery. Patients were maintained nil per oral for duration of 10 hours prior to surgery.

To test the efficacy of drugs for use during emergency surgeries, a technique mimicking rapid sequence induction was employed in patients posted for elective surgeries.

The baseline heart rate, oxygen saturation and electrocardiogram, systolic, diastolic, mean arterial blood pressure was recorded.

Injection Glycopyrolate 0.2mg and injection midazolam 1mg were given to all patients 3 minutes prior to administering induction agent.

All patients were preoxygenated with 100% oxygen via a face mask for 3 minutes after administering glycopyrolate and midazolam. They were induced with injection thiopentone sodium 5mg kg⁻¹ body weight intravenously.

In all patients cricoid pressure was applied after the administration of induction agent when the patients become unconscious.

In group I, succinylcholine chloride 1mg kg⁻¹ body weight was given intravenously after the loss of eyelash reflex.

Similarly in group II and group III, rocuronium bromide 0.6mg kg⁻¹ and 0.9mg kg⁻¹ respectively was given intravenously after the loss of eyelash reflex. No mask ventilation was done in any patient after administration of relaxant.

In all the three groups of patients, oral endotracheal intubation was attempted at 60 seconds following the administration of muscle relaxant and intubating conditions were graded using the score adopted by Toni Magorian et al. (1993)³

- Excellent = Jaw relaxed, vocal cords apart and immobile, no diaphragmatic movements.
- Good = Jaw relaxed, vocal cords apart and immobile, some diaphragmatic movements.
- Poor = Jaw relaxed, vocal cords moving, "bucking".
- Inadequate = Jaw not relaxed, vocal cords closed.

All the patients were intubated with well lubricated appropriate sized poly vinyl chloride endo tracheal tubes (cuffed) bilateral air entry was checked and the tube was firmly secured.

ORIGINAL ARTICLE

Maintenance of anaesthesia was done with 30% oxygen and 70% nitrous oxide and Controlled Mandatory ventilation.

Monitoring of vital parameters like heart rate, oxygen saturation, systolic, diastolic and mean arterial blood pressures, electrocardiogram, capnograph were recorded 1, 3 and 5 minutes following intubation.

The clinical duration of action that is the time from administration of relaxant to first attempt at respiration of was noted. Subsequently, the muscle relaxation was maintained with vecuronium bromide 0.04 mg kg⁻¹ body weight till the end.

At the end of surgery all the patients were reversed with injection neostigmine 0.05 mg kg⁻¹ body weight and injection glycopyrolate 0.01 mg kg⁻¹ body weight.

Other side effects like histamine releasing property associated with administration of rocuronium bromide and succinylcholine chloride were also noted.

The haemodynamic parameters in the present study were compared statistically using p value obtained from student t-test.

OBSERVATION AND RESULTS:

The age distribution of all patients of all the three groups is as shown below.

Age groups	Group I (n = 30)	%	Group II (n = 30)	%	Group III (n = 30)	%
18-30 years	12	40	17	56.67	17	56.67
31-40 years	10	33.34	9	30	10	33.33
41-50 years	7	23.33	4	13.34	3	10
51-60 years	1	3.33	-	-	-	-
Mean age	34.5 years		30.43 years		33.03 years	
Maximum age	55 years		50 years		50 years	
Minimum age	18 years		18 years		22 years	

Table 1: Age distribution

The following table shows the sex distribution in the three groups.

Sex	Group I (n = 30)	%	Group II (n = 30)	%	Group III (n = 30)	%
Male	9	30	18	60	10	33.34
Female	21	70	12	40	20	66.66

Table 2: Age distribution

The following table shows the weight distribution of the three groups.

ORIGINAL ARTICLE

Weight	Group I (n = 30)	%	Group II (n = 30)	%	Group III (n = 30)	%
35-45 kg	9	30	4	13.33	10	33.33
46-55 kg	13	43.33	12	40	16	53.33
56-65 kg	6	20	12	40	4	13.34
66-75 kg	2	6.67	2	6.67	-	-
Mean weight	51.34 kg		54.16 kg		49.13 kg	
Maximum weight	68 kg		71 kg		63 kg	
Minimum weight	41 kg		35 kg		40 kg	

Table 3: Weight distribution

Based on the scale adopted by Toni Magorian et al.³

Scores	Group I (n = 30)		Group II (n = 30)		Group III (n = 30)	
	No. of patients	%	No. of patients	%	No. of patients	%
Excellent	30	100	16	53.33	29	96.67
Good	-	-	13	43.33	1	3.33
Poor	-	-	1	3.34	-	-
Inadequate	-	-	-	-	-	-

Table 4: Intubation Score

Duration	No. of patients	Percentage
3-5 min	17	56.67
5.1-7 min	12	40
7.1-9.0 min	1	3.33
Mean duration	4.77±0.99 minutes	
Maximum duration	8.25 minutes	
Minimum duration	3.5 minutes	

Table 5: Duration of action of succinylcholine chloride

ORIGINAL ARTICLE

Duration	No. of patients	Percentage
20-25 minutes	4	13.33
26-30 minutes	24	80
31-35 minutes	2	6.67
Mean duration	27.4± 2.14 minutes	
Maximum duration	32 minutes	
Minimum duration	22 minutes	

Table 6: Duration of action of rocuronium bromide 0.6 mg kg⁻¹ body weight

Duration	No. of patients	Percentage
40-45 min	17	56.67
46-50 min	8	26.66
51-55 min	5	16.67
Mean duration	45.33±3.73 minutes	
Maximum duration	52 minutes	
Minimum duration	40 minutes	

Table 7: Duration of action of rocuronium bromide 0.9 mg kg⁻¹ body weight

	Group I Succinylcholine chloride 1mg kg ⁻¹		Group II Rocuronium bromide 0.6mg kg ⁻¹		Group III Rocuronium bromide 0.9mg kg ⁻¹	
	Beats per minute	%	Beats per minute	%	Beats per minute	%
Pre induction	86.20 SD=9.539 SEm=1.742		85.97 SD=11.577 SEm=2.114		87.43 SD=10.109 SEm=1.846	
One minute after intubation	117.30 SD=11.721 SEm=2.140	+36.07	118.37 SD=12.254 SEm=2.237	+37.69	115.67 SD=8.770 SEm=1.601	+32.28
Three minute After intubation	104.03 SD=10.156 SEm=1.854	+20.68	104.23 SD=10.177 SEm=1.858	+21.25	102.53 SD=8.513 SEm=1.554	+17.27
Five minute after intubation	89.83 SD=9.374 SEm=1.711	+4.21	89.73 SD=10.279 SEm=1.877	+4.38	90.23 SD=8.003 SEm=1.461	+3.20

Table 8: Mean Heart rate (beats/min)

ORIGINAL ARTICLE

As shown in table 8, there was a significant ($p < 0.05$) rise in mean heart rate by 36.07%, 37.69% and 32.28% from pre induction value in Group I, II, III respectively.

This increase in mean heart rate declined to 4.21%, 4.38% and 3.20% from base line at 5 minutes following intubation.

	Group I		Group II		Group III	
	mm Hg	%	mm Hg	%	mm Hg	%
Pre induction	90.8 SD=7.654 SEm=1.397		90.83 SD=6.849 SEm=1.250		92.37 SD=6.557 SEm=1.197	
One minute after intubation	119.17 SD=11.216 SEm=2.048	+31.23	121.47 SD=9.183 SEm=1.677	+33.72	122.03 SD=7.912 SEm=1.469	+31.98
Three minute after intubation	106.30 SD=8.979 SEm=1.639	+17.07	108.33 SD=10.159 SEm=1.855	+19.26	105.10 SD=8.470 SEm=1.546	+13.79
Five minute after intubation	91.23 SD=11.041 SEm=2.016	+0.47	95.9 SD=9.382 SEm=1.713	+5.58	93.17 SD=5.908 SEm=1.079	+0.86

Table 9: Mean Arterial pressure

As shown in table 9, there was a significant ($p < 0.05$) rise in mean arterial pressure by 31.23%, 33.72%, 31.98% from pre induction value at 1 minute following intubation in Group I, Group II, Group III respectively.

DISCUSSION: Prior to the introduction of muscle relaxants, inhalational agents were used for endotracheal intubation. Inhalational technique was associated with its own complications when intubation was attempted with inadequate depth. The complications noted were laryngospasm and bronchospasm. Further to achieve adequate intubating conditions, higher concentrations of these inhalational agents needed to be used which were associated with haemodynamic disturbances.

Succinylcholine chloride introduced in 1951 was unparalleled in terms of its onset and duration of action. The type of relaxation obtained with this drug was so good but the adverse effects of succinylcholine chloride, like bradycardia, nodal and junctional rhythms, rise in intraocular, intracranial pressure started surfacing, quest began for better relaxants devoid of these adverse effects

Rocuronium bromide introduced in 1994 became the first drug to challenge the onset time of succinylcholine chloride, in that it produces good to excellent intubating conditions in 60 seconds. In addition to this rocuronium bromide is devoid of adverse effects of succinylcholine chloride.

In view of this, the present study was undertaken to compare the intubating conditions of rocuronium bromide with that of succinylcholine chloride at 60 seconds.

ORIGINAL ARTICLE

Dosage Selected: The dosage of the neuromuscular blocking drug selected is usually based on the ED95 value. The dose of relaxant needed for endotracheal intubation is usually more and is employed in multiples of ED95 dose.

The ED95 dose of succinylcholine chloride is 0.392 mg kg⁻¹ body weight. Three times the ED95 dose which approximates 1 mg kg⁻¹ body weight has been employed for intubation in the present study.

Rocuronium bromide has been employed in two to three times the ED95 dose to obtain excellent intubating conditions. The ED95 of rocuronium bromide is 0.3 mg kg⁻¹ body weight.

Hence in our study rocuronium bromide has been employed in two doses, i.e. 0.6 mg kg⁻¹ body weight and 0.9 mg kg⁻¹ body weight.

Intubation Time: Selecting the time for intubation can be either by neuromuscular monitoring or by clinical method.

Various authors have employed neuromuscular monitoring for assessing the time for intubation. They have defined the onset time as the time from injection of drug to 95% twitch height depression. However, with non-depolarizing muscle relaxant like rocuronium bromide it has been found that the onset of paralysis at laryngeal muscles preceded that at adductor pollicis and hence monitoring of train of four at adductor pollicis may not give correct picture of intubating conditions.^{4,5}

Intubating conditions is usually assessed using clinical criteria such as jaw relaxation, vocal cord movements and diaphragmatic relaxation.

In the present study clinical criteria was adopted for scaling intubating conditions at 60 seconds.

Intubating Conditions: In the present study involved comparison of succinylcholine chloride 1mg kg⁻¹ body weight with rocuronium bromide 0.6 mg kg⁻¹ body weight and 0.9mg kg⁻¹ body weight for rapid sequence intubation in adult patients. It was noted that succinylcholine chloride 1mg kg⁻¹ body weight produced excellent intubating conditions in 100% of patients. Rocuronium bromide 0.6 mg kg⁻¹ body weight produced excellent intubating conditions in 53.33% of cases, good intubating conditions in 43.33% and poor intubating conditions in 3.34% of cases. Rocuronium bromide 0.9mg kg⁻¹ body weight produced excellent intubating conditions in 96.67% of cases and good intubating conditions in 3.33% of cases. The present study is comparable with study of Naguib M. et al.⁶

Thus increasing the dose of rocuronium bromide from 0.6mg kg⁻¹ to 0.9mg kg⁻¹ body weight increased the incidence of excellent intubating conditions but at the cost of increased duration of action. The study results are comparable to Toni Magorian et al,³ Cooper et al,⁷ Friedrich K., Puhlinger et al⁸ and K. C. McCourt et al.⁹

DURATION OF ACTION: The clinical duration of succinylcholine chloride 1mg kg⁻¹ body weight in the present study was found to range between a minimum of 3.5 minutes (Case no. 3) to a maximum of 8.25 minutes (Case no. 11) with a mean duration of action of 4.773±0.99 minutes, similar to studies of Naguib M. et al⁶ and Dhonneur et al.¹⁰

ORIGINAL ARTICLE

The minimum clinical duration for rocuronium bromide 0.6 mg kg⁻¹ body weight in present study was 22 minutes, maximum duration was 32 minutes with a mean duration of 27±2.14 minutes. which concurs with studies of Naguib M. et al,⁶ P. Schultz et al.¹¹ And Aparna Shukla et al¹², similarly the minimum duration of action for rocuronium bromide 0.9 mg kg⁻¹ in present study was 40 minutes and maximum duration was 52 minutes with a mean of 45.33±3.73 minutes, which concurs with studies of Toni Magorian et al³ and P. Schultz et al.¹¹

Cardiovascular Changes: There was a rise in mean heart rate by 37.69% and 32.28% following administration of rocuronium bromide 0.6 mg kg⁻¹ body weight and 0.9 mg kg⁻¹ body weight, one minute following intubation. There was a similar increase in mean arterial pressure by 33.72% and 31.98% from pre induction value following rocuronium bromide 0.6 mg kg⁻¹ and 0.9 mg kg⁻¹ body weight one minute following intubation. This was a haemodynamic response to laryngoscopy and endotracheal intubation which subsided to near pre induction values 5 minutes after intubation.

Similar trends were seen following the administration of succinylcholine chloride 1 mg kg⁻¹ body weight. There was a rise in mean heart rate by 36.07% from pre induction value one minute after intubation. There was also a rise in mean arterial pressure by 31.23% from pre induction value one minute after intubation. These values returned towards pre induction values 5 minutes following intubation.

Thus there were no haemodynamic disturbances following administration of succinylcholine chloride and rocuronium bromide and rise in mean heart rate and blood pressure was a response to laryngoscopy and intubation.

Untoward Side Effects: No patient in succinylcholine chloride group had any signs of histamine release. There was no bronchospasm or rash associated with fall in blood pressure. No other patients in the rocuronium bromide groups had any clinical evidence of histamine release (e.g. flushing, rash, bronchospasm).

CONCLUSION:

1. Succinylcholine chloride 1 mg kg⁻¹ body weight produces excellent intubating conditions in all the patients at 60 seconds with an average clinical duration of action of 4.77±0.99 minutes.
2. Rocuronium bromide 0.6 mg kg⁻¹ body weight produces good to excellent intubating conditions in 96.67% of patients at 60 seconds (96.67%) with an average clinical duration of action of 27.4±2.14 minutes.
3. Rocuronium bromide 0.9 mg kg⁻¹ body weight produces excellent intubating conditions in 96.67% of patients and good to excellent intubating conditions in 100% of patients at 60 seconds with an average clinical duration of action of 45.33±3.73 minutes.
4. Increasing the dose of rocuronium bromide from 0.6 mg kg⁻¹ body weight to 0.9 mg kg⁻¹ body weight increases the incidence of excellent intubating conditions but at the cost of increased duration of duration.

ORIGINAL ARTICLE

5. Rocuronium bromide is a safe alternative to succinylcholine chloride for rapid sequence induction in adult patients in situations where succinylcholine is contraindicated and in whom there is no anticipated difficult airway.

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ORIGINAL ARTICLE

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