International Journal of Biomedical Research
ISSN: 0976-9633 (Online); 2455-0566 (Print)
Journal DOI: 10.7439/ijbr
CODEN: IJBRFA

Original Research Article

Comparison of rocuronium bromide and succinylcholine chloride for use during rapid sequence intubation in adult patients

Sasidharan Nair M*, Sweetline Subha M and Sreejith H

Department of Anaesthesia, Dr. SMCSI Medical College, Karakonam, Trivanadrum, Kerala -695504

***Correspondence Info:**
Dr. Sasidharan Nair. M, M.D
Assistant Professor
Department of Anaesthesia,
Dr. SMCSI Medical College,
Karakonam, Trivandrum, Kerala -695504
E-mail: sasidharannairm@yahoo.com

Abstract

The introduction of endotracheal intubation during First World War and introduction of balanced anaesthesia in 1926, urged the search for a drug which could cause Jaw relaxation to facilitate endotracheal intubation.Succinylcholine chloride introduced in 1951, was a synthetic depolarising 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. Because of its adverse effects like hyperkalemia, rise in intragastric, intraocular, intracranial pressures and cardiovascular effects, a quest began for a safer substitute for Succinylcholine chloride. 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 1 mg/kg body weight and to compare the intubating conditions with that of Succinylcholine chloride 1.5 mg/kg body weight, for use during rapid sequence intubation in adult patients. Rocuronium bromide 1 mg/kg body weight produces excellent intubating conditions in 96.67% of patients and good to excellent intubating conditions in 100% of patients at 60 seonds with an average clinical duration of action of 49 minute and 10 seonds.

Keywords: Intubation, Succinylcholine, Rocuronium bromide.

1. Introduction

The introduction of endotracheal intubation during First World War and introduction of balanced anaesthesia in 1926, urged the search for a drug which could cause Jaw relaxation to facilitate endotracheal intubation. Most of the intubations were done with inhalational technique which was associated with problems like laryngospasm and bronchospasm. Further there was a need to take the patient sufficiently in deeper anaesthetic plane before intubation, which lead to hemodynamic disturbances.[1]

The skeletal muscle relaxant d-tubocurarine which was non-depolarising 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 has delayed onset at jaw, making it unsuitable for use during rapid sequence intubation in emergency cases. Hence a research began for a relaxant which had rapid onset and short duration of action.[3]

Succinylcholine chloride introduced in 1951, was a synthetic depolarising muscle relaxant. It fulfilled both of the above requirements and soon became the drug of choice for endotracheal intubation specially in rapid sequence intubation in emergency cases. Because of its adverse effects like hyperkalemia, rise in intragastric, intraocular, intracranial pressures and cardiovascular effects, a 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, vecuronium and mivacurium 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 1 mg/kg body weight and to compare the intubating conditions with that of Succinylcholine chloride 1.5 mg/kg body weight, for use during rapid sequence intubation in adult patients.

2. Methodology

A double blind clinical study comparing rocuronium bromide 1 mg/kg and Succinylcholine chloride 1.5 mg/kg for use during rapid sequence intubation of anaesthesia in adult patients was undertaken at Vinayaka Mission's Medical College and Hospital, Karaikal, Puducherry during the period 15-11-2009 to 10-05-2011 after obtaining ethical committee clearance.

The study population consisted of 60 adults patients of ASA grade I and II belonging to both sexes in the age group of 18-60 years who were posted for various emergency surgeries at Vinayaka Mission's Medical College and Hospital. Informed written consent was obatained from patients before taking up for surgery. Exclusion criteria consisted of patients with ischemic heart disease, medication with drugs that interact with neuromuscular transmission viz Aminoglycosides, Calcium channel blockers etc, history of drug allergy, obesity, neuromuscular disorders and anticipated difficult airway.

The study population was randomly divided into 2 groups, with 30 patients in each group.

Group I consisting of 30 patients were to receive Succinylcholine chloride 1.5 mg/kg body weight and intubation attempted at 60 seconds.

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

Patient was assessed in the pre op holding room regarding the general physical conditions, any existing systemic illness, the present cardiopulmonary status, airway assessment including mallampatti grading, jaw movements, neck movements, thyromental distance and dentition. All the basic investigations like haemoglobin, total and differential blood count, bleeding and clotting time, random blood sugar, blood urea, serum creatinine, chest X-Ray and ECG were done preoperatively.

Patients were premedicated with Inj Ranitidine 50 mg IV and Inj Metaclopromide 10 mg IV half an hour before surgery. All patients were practically considered to be full stomach anticipating the risk of pulmonary aspiration.

In the operating room anaestheia machines, cylinders and breathing circuits were checked. Also made sure that emergency drugs, MacIntosh and McCoy laryngoscopes, appropriate size airways, bougie and stylet were available.

Prior to surgery after the patient had been shifted to the operating room an Intravenous line was secured with an 18 Guage Intravenous cannula and patient connecting to multichannel monitor consisting of pulse oximeter, electrocardiogram, heart rate, non-invasive blood pressure and $EtCO_2$. The baseline heart rate, oxygen saturation and electrocardiogram, systolic, diastolic, mean arterial blood pressure and $EtCO_2$ were recorded.

Inj Pentazocine 30 mg, Inj Midazolam 1 mg and Inj Glycopyrrolate 0.2 mg were given intravenousy to all patients 3 minutes prior to administering induction agents. All the patient were preoxygeneated with 100%oxygen via a face mask for 3 minutes after administering Pentazocine, Midazolam and Glycopyrrolate. They were induced with Inj. Thiopentone sodium 5 mg/kg body weight intravenously.

In all patients cricoid pressure was applied by an assistant after induction as soon as patient became unconscious and continued till the ETT was in place. In Group I Succinylcholine chloride 1.5 mg/kg body weight was given intravenously after the loss of eye lash reflex. Similarly in Group II rocuronium bromide 1 mg/kg body wieght was given intravenously after the loss of eye lash reflex. No mask ventilation was done in any patient after administration of relaxant. Laryngoscopy was attempted at 60 sec. by a senior anasethesiologist (who was blinded to the drug group the patient belonged), the C & L grading and intubating conditions were assessed and graded and appropriate sized ETT was passed. Bilateral air entry was checked and the tube was firmly secured by inflating the cuff. Then the cricoids pressure was released.

The intubating conditions were graded using the score adopted by Toni Magorian *et al*[8] (1993) as shown below.

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 and bucking

Inadequate = Jaw not relaxed, vocal cords closed.

Manitenance of anasethesia was done with 40% oxygen and 60% nitrous oxide and halothane and intermittent positive pressure ventilation (IPPV) on Bain's circuit. Monitoring of vital parameters like heart rate oxygen saturation, systolilc and mean arterial pressure, electrocardiogram and Et CO_2 were recorded at 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 initial bolus doses of Succinylcholine chloride and rocuronium bromide was noted. Subsequently, the muscle relaxation was maintained with intermittent dose of rocuroium bromide 0.1 mg/kg body weight till the end of the surgery. At the end of surgery all the patients were reversed with Inj. Neostigmine 0.05 mg/kg body weight and Inj Glycopyrrolate 10 micrograms/kg body weight. Other side effects like histamine releasing property associated with administration of rocuronium bromide and Succinylcholine chloride were also noted.

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

3. Results

3.1 Age distribution

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

Table 1: The age distribution of all patients in the two groups

Age Groups	Group I (n=30)	%	Group II (n=30)	%
18-30 years	7	23.33	2	6.67
31-40 years	9	30	10	33.33
41-50 years	6	20	10	33.33
51-60 years	8	26.67	8	26.67
Mean age	40.96		43.86	
Maximum age	58		60	
Minimum age	20		22	

3.2 Sex Distribution

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

Table 2: Sex distribution in the two groups

Sex	Group I (n=30)	%	Group II (n=30)	%
Male	18	60	21	70
Female	12	40	9	30

3.3 Weight Distribution

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

Table 3: Weight distribution of the two groups

Weight	GroupI (n=30	%	Group II (n=30)	%
35-45 kg	7	23.33	5	16.67
46-55 kg	6	20	12	40
56-65 kg	16	53.33	10	33.33
66-75 kg	1	3.33	3	10
Mean Weight	54.5		53.9	
Maximum weight	68		68	
Minimum Weight	38		40	

3.4 Intubation Score

{Based on the study adopted by Toni Magorian *et al*[8]}

Table 4: Intubation Score

Scores	Group I (n=30)		Group II (n=30)	
	No. of patients	%	No. of patients	%
Excellent	30	100	29	96.67
Good	0	0	1	3.33
Poor	0	0	0	0
Inadequate	0	0	0	0

As it is seen in the Table 4 in Group I patients who received Succinylcholine chloride 1.5 mg/kg body weight, all pateints had excellent intubating conditions with jaw relaxed, vocal cords apart and immobile and no diapharagmatic movements.

In Group II patients who received rocuronium bromide 1 mg/kg body weight, 29 patients out of 30 had excellent intubating conditions with 1 pateint having good intubating condition. There was no case of failed intubation at 60 seconds in any of the two groups.

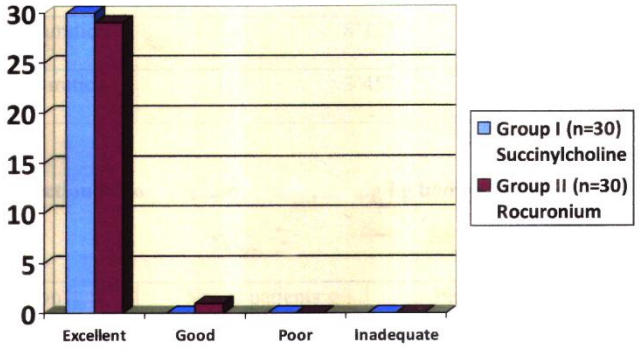

Figure 1: Graph showing intubation score

3.5 Duration of action of Succinylcholine chloride 1.5 mg/kg body weight

Table 5: Duration of action of Succinylcholine chloride

Duration	No. of patients	Percentage
3-5 min	11	36.66
5.1-7 min	17	56.67
7.1-9.0 min	2	6.66
Mean duration	5’12’’	
Maximum duration	8’15”	
Minimum duration	3’45”	

3.6 Duration of action rocuronium bromide 1 mg/kg body weight

Table 6: Duration of action rocuronium bromide

Duration	No. of patients	Percentage
40-45 min	5	16.66
46-50 min	8	26.66
51-55 min	17	56.67
Mean duration	49’10”	
Maximum duration	55’	
Minimum Duraiton	40’	

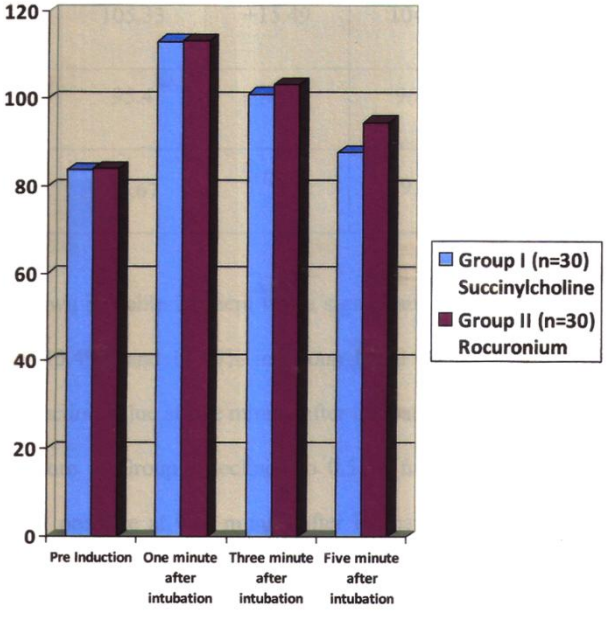

Figure 2: Graph showing mean heart rate

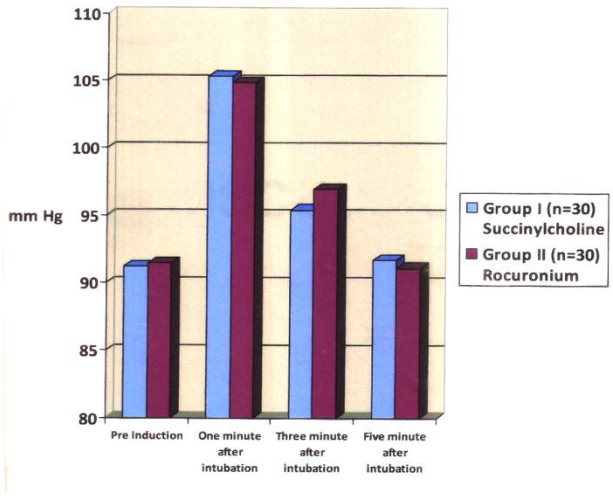

Figure 3: Graph showing mean arterial pressure

4. Discussion

Securing the airway by an endotracheal tube rapidly and safely is of paramount importance and to minimise the chances of regurgitation and aspiration of gastric contents in practice of general anaesthesia. Prior to introduction of muscle relaxants inhalational agents were used for endotracheal intubation and associated with much compliance like inadequate depth, laryngospasm, bronchospasm and sensitisation of myocardium to cathecolamines.

Since the introduction of concept of Balanced anaesthesia in 1926 by John S Lundy, which was later modified by Rees and Gray the search went on for a relaxant to complete the idea of narcosis, reflex suppression and relaxation. A breakthrough discovery in 1942 when d-tubocurarine was introduced into clinical anaesthesia. Though d-tubocurarine produced an excellent jaw relaxation to facilitate endotracheal intubation, it had its own drawbacks. The onset of action was slow, taking up to 3 minutes to produce good intubating conditions. This made the drug unsuitable for use in emergency cases and full stomach cases where rapid airway procurement is the goal.

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 that even today it is used as a gold standard and other drugs are compared with it. But with time as the adverse effects of Succinylcholine chloride, like bradycardia, nodal and junctional rhythms, rise in intraocular, intracranial pressure were observed and development of Phase 2 block after large dose or continuous infusion, also duration of Succinylcholine was prolonged in patients with pseudocholinesterase deficiency.

The speed of onset is inversely proportional to the potency of nondepolarising neuromuscluar blockers. Rocuronium has a molar potency of ED95 0.54 microgram/kg, that is about 13% that of the vecuronium and only 9% of cisatracurium.

Rocuronium bromide (ORG 9426) was introduced in 1994 in order to provide a very rapid relaxation for endotracheal intubation. It was synthesized from its parent molecule vecuronium bromide by various substitutions by Dr. T. Sleigh and Dr. Savage at Organon Lab.

In view of this the present study compares the intubating conditions and haemodynamic responses of rocuronium and succinyl choline at 60 seconds.

4.1 Intubating dose

Selection of dosage of neuromuscular blockers is usually based on ED 95 value. ED95 is the dose of relaxant needed to produce 95% suppression of the single twitch response. 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 body weight. Four times the ED95 dose which approximates 1.5 mg/kg body weight has been employed for intubation in the present study which is similar to other authors. [11][13][14].

The ED95 of rocuronium is 0.3 mg/kg body weight. In the present study the dose used is approximately 3 times the ED95 dose i.e., 1 mg/kg body weight. It has been shown to provide good to excellent intubating condition at 60 sec and this can be compared to study by other authors. [7][8][9].

4.2 Intubation time

The goal of general anaesthesia is securing airway non traumatically at the earliest i.e., within 60 sec. The time for intubation can be determined either by neuromuscular monitoring or by clinical methods.

Various authors have employed neuromuscular monitoring for assessing the time for intubation. They have defined the onset time from injection of drug to 95% twitch height depression. But the neuromuscular monitoring elsewhere is not a good determinant of paralysis at laryngeal muscles.

Rapid sequences intubation involves rapid procurement of airway usually at 60 seconds and intubating conditions are scaled at 60 seconds. Intubating condition is usually assessed using clinical criteria such as jaw relaxation, vocal cord movements and diaphragmatic relaxation. Most of the authors have preferred to use these clinical criteria for intubation at 60 seconds [10]- [12].

Hence in the present study clinical criteria as adopted by Toni Magorian *et al*[8] (1993) were used for scaling intubating condition at 60 sec.

4.3 Intubating condition

Intubating condictions judged by clinical criteria scaled accordingly by various authors. Many authors have employed Succinylcholine 1.5 mg/kg body weight and rocuronium 0.9 mg/kg body weight. In the present study we have used rocuronium bromide 1 mg/kg body weight.

The intubating conditions with Succinylcholine Chloride 1.5 mg/kg at 60 seconds by various authors and present study are shown below.

Table 7: Intubating conditions with Succinylcholine Chloride

Authors	Excellent	Good	Poor	Inadeqaute
Alekshandra J Mazurek *et al* (1998)[13]	10(76.92%)	2(15.38%)	1(7.69%)	-
Huizinga ACT *et al*(1992)[11]	8(80%)	1(10%)	1(10%)	-
Aparna Shukla *et al* (2004)[14]	19(95%)	1(5%)	-	-
Present study (n=30)	30(100%)	-	-	-

It is noted that with Succinylcholine 1.5 mg/kg body weight. Aleksandra *et al*[13], Huizinga *et al*[11] and Shulka *et al*[14] have obtained 76.92%, 80% and 95% respectively. Only 2 authors Aleksandra *et al*[13] and Huizinga *et al*[11] have noted poor intubating condition in 7.69% and 10% respectively.

In Huizinga *et al*[11] case laryngoscopy failed in one patient 60 sec after administration of Succinylcholine. Leary N P *et al* (1990) showed a temporary increase in masseteric muscle tone after administration of Succinylcholine. This made laryngoscopy difficult at 60 sec, however at 120 sec intubating condition was excellent due to a change from contraction to flaccid paralysis of masseter muscle.

In the present study Succinylcholine 1.5 mg/kg body weight produced excellent condition in 100% (n=30) of cases which is comparable with that of Shukla *et al*[14].

Intubating conditions with rocuroium bromide 0.9 mg/kg body weight at 60 seconds byvarious authors and present study is shown below.

Table 8: Intubating conditions with rocuroium bromide

Authors	Excellent	Good	Poor	Inadequate
1. Toni Magorian *et al*. 1993 (=10)	8(80%)	2(20%)	-	-
2.Fuchs Buder *et al*. 1996 (n=35)	33(94%)	2(6%)	-	-
3.Naguib M. *et al*. 1997 (n=10)	10(100%)	-	-	-
4.P. Schultz *et al*. 2001 (n=36) 44	29(80.5%)	6(16.67%)	1(2.78%)	-

Table 9: Present study with rocuronium bromide 1 mg/kg body weight.

Authors	Excellent	Good	Poor	Inadequate
Present study (n=30)	29(96.67%)	1(3.33%)	-	-

Thus it is noted that the incidence of excellent intubating conditions with rocuronium bromide 0.9 mg/kg body weight ranged from 80% in the study of Toni *et al*[8] to 100% in the study of Naguib *et al*[18]. The incidence of good intubating conditions ranged from 6% in the study of Fuchs Buder *et al*. (1996) to 20% in the study of Toni *et al*[8]. Only Schultz *et al* noted the incidence of poor intubating condition in 1(2.78%) patient.

In the present study 96.67% of patients had excellent intubating conditions with rocuronium bromide 1 mg/kg body weight at 60 seconds which is comparable with studies of Naguib *et al*[18].

Only 1 patient (3.33%) has good intubating condition which is comparable to the study of Fuchs Buder *et al*. (1996), Toni Magorain *et al*. 1993. There was no case of poor intubating condition with rocuronium bromide 1 mg/kg body weight.

Comparison of intubating conditions of rocuronium bromide 0.9 mg/kg weight with Succinylcholine chloride 1.5 mg/kg body weight as noted by various authors and present study.

Table 10: Comparison of intubating conditions of rocuronium bromide with Succinylcholine chloride Neerja B *et al* (1999) (n=15 and 19 respectively)

Succinylcholine bromide 1.5 mg/kg				Rocuronium bromide 0.9 mg/kg			
Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
11 (73.33%)	4 (26.66%)	-	-	19(100%)	0	-	-

Table 11: Present study with rocuronium bromide 1 mg/kg body weight (n=30 each)

Succinylcholine chloride 1.5 mg/kg				Rocuronium bromide 1 mg/kg			
Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
30(100%)	-	-	-	29 (96.67%)	1(3.33%)	-	-

The authors who have compared Succinylcholine chloride 1.5 mg/kg body weight and rocuronium bromide 0.9 mg/kg body weight have noted that both drugs produce excellent intubating conditions in majority of patients and produce good to excellent intubating conditions in 100% of patients.

In the present study also Succinylcholine chloride 1.5 mg/kg body weight produced excellent intubating conditions in 100% of patients. Ronuroium bromide 1 mg/kg body weight produced excellent intubating conditions in 96.67% of cases and good to excellent intubating conditions in 100% of patients which concurs with studies of Neerja B *et al*(1999).

4.4 Haemodynamic effects [15-17]

The haemodynamic changes following the administration of rocuronium bromode have been studied by Eamon *et al*[16] and Mark *et al*[15].

Eamon *et al*[16] have demonstrated changes in heart rate (+7%), mean arterial pressure (-5%), systematic vascular resistance (-12%), that were insignifianct. They concluded that rocuroium bromide in doses of 0.6 mg/kg is associated with changes of only small magnitudes in haemodynamic variables.

Mark E. Hudson *et al*. 1998 measured the haemodynamic effects of rocuronium bromide in adults undergoing cardiac surgery with cardiopulmonary bypass. There was no change in mycocardial oxygen demand and supply. Although CVP and PAP decreased significantly, rocuronium bromide had no effect on pulmonary capillary wedge pressure systematic vascular resistance, mean arterial pressure and cardiac index. Thus rocuronium bromide has been demonstrated to be haemodynamically a stable drug.

In our study, there was no change in haemodynamic variables following the administration of rocuronium bromide. There was a rise in mean heart rate by 34.74% following administration of rocuronium bromide 1mg/kg body weight, one minute following intubation. There was a similar increase in mean arterial pressure by 14.65% from pre induction value following rocuronium bromode 1 mg/kg body weight one minute following intubation. This was a haemodynamic response to laryngoscopy and endotracheal intubation, which subsided to near pre induction, value 5 minutes after intubation.

Similar trends were seen following the administration of Succinylcholine chloride 1.5 mg/kg body weight. There was a rise in mean heart rate by 35.20% from pre induction value one minute after intubation. There was also a rise in mean arterial pressure by 15.49% from pre induction value one minute after intubation. These values returned towards pre induction values 5 minutes following intubation.

Trend in haemodynamic changes to laryngoscopy and intubation were similar in both Succinylcholine chloride and rocuronium bromide.

4.5 Untoward side effects [18]

Various authors have demonstrated the safety of rocuronium bromde when administrated in two to three time the ED95 dose.

Levy *et al*[17] have demonstrated no increase in plasma histamine levels at 1, 3 and 5 minute after the rapid iv bolus of 06, 0.9, 1.2 mg/kg body weight rocuronium bromide. Clinical signs of histamine release (e.g. flushing, rash, bronchospasm) associated with administration of rucuronium bromide was reported in 9 of 1137 (0.8%) patients. Thus rocuronium bromide is proved to have minimal to nil histamine releasing preperty.

Chiu *et al* has demonstrated no significant effects on the intra ocular pressure following administration of rocuronium bromide. 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. This concurs with study of Levy *et al*[17].

No patient in Succinylcholine chloride group had any signs of histamine release. No untoward side effect was noted was noted in both the groups in the present study.

5. Conclusion

1) Succinylcholine chloride 1.5 mg/kg body weight produces excellent intubating conditions in all the patients at 60 seconds with an average clinical duration of action of 5 minute and 12 seconds.
2) Rocuronium bromide 1 mg/kg body weight produces excellent intubating conditions in 96.67% of patients and good to excellent intubating conditions in 100% of patients at 60 seonds with an average clinical duration of action of 49 minute and 10 seonds.
3) Rocuronium bromide is a safe alternative to Succinylcholine chloride for rapid sequence intubation in adult patients in situations where Succinylcholine chloride is contraindicated and in whom there is no anticipated difficult airway.

6. Summary

The present study entitled “Comparison of rocuronium bromide succinylcholine chloride for use during rapid sequence intubation in adult patients” was carried at Vinayaka Mission’s Medical College and Hospital, Karaikal from 15-11-2009 to 10-05-2011 after obtaining ethical committee clearance. The study population consisted of 60 patients divided into two groups. Group I (n=30) was intubated with Succinylcholine chloride 1.5 mg/kg body weight. Group II (n=30) was intubated with rocuroium bromide 1 mg/kg body weight. In all the two groups intubation was attempted at 60 seconds following injection of neuromuscular blocking drug. The results of present study are as follows.

Table 12:

Sl. No.	Particulars	Group I Succinylcholine chloride 1.5 mg/kg (n=30)	Group II Rocuronium bromide 1 mg/kg (n=30)
1	Mean age (years)	40.96	43.86
2	Mean Weight (kg)	54.5	53.9
3	Male : Female ratio	18:12	21:9
4	Mean dose (mg)	81.75	53.9
5	Intubating conditions (a) Excellent (b) Good (c) Poor (d) Inadequate	30(100%) - - -	29(96.67%) 1(3.33%) - -
6	Clinical duration of action (min)	5'12"	49'10"
7	Mean heart rate (beats/min) (a) Baseline (pre induction) (b) 1 min after induction (c)3 min after indunction (d)5 min after induction	8367 113.13 100.96 87.63	84.06 113.27 103.17 94.57
8.	Mean blood pressure (mm Hg) (a) Baseline (pre induction) (b)1 min after induction (c)3 min after indunction (d)5 min after induction	91.12 105.33 95.4 91.67	91.47 104.87 96.97 91.1

References

[1] Atkinson RS, Rushman GB, Davies NJH: Lee's synopsis of Anaesthesia, 11th Edition, 1998, p. 130-132.

[2] Ronald D Miller: Anaesthesia, Chirchill Livingstone, 5th Edition, 2000, p. 419, 446, 448, 449, 450, 452.

[3] Savarese JJ: autonomic margin of safety of metacurine and d-tubocurarine in the cat, *Anaesthesiology*, 1979; 50:40.

[4] Cooper R, Mirakhur RK, Clarke RSJ and Boules Z: Comparison of intubating conditions after administration of Org 9426 (Rocuronium) and Suxamethonium, *British Journal of Anaesthesia*, 1992; 69: 269-273.

[5] Huizinga ACT, Vandenbrom RHG, Wierda MKH, Hommu FDM, Hennis PJ: Intubating conditions and onset of neuromuscular block or rocuronium (Org 9426); a comparison with suxamethonium: *Acta Anaeshesiol Scnad*, 1992; 36: 463-468.

[6] Perry JJ, Lee JS, Sillberg VAH, Wells GA. Rocuronium versus Succinylcholine for rapid sequence inducction intubation. *Cochrane Database of Systematic Reviews* 2008, Issue 2, Art No.: CD002788. DOI: 10.1002/14651858. CD002788.pub2.

[7] Crul JF, Vanbelleghem V, Buyse L, Heylen R, Van Egmond J: Rocuronium with alfentanil and propofol allows intubation within 45 seconds, *European Journal of Anaesthesiology*, 1995; 12:111-112.

[8] Toni Magorian, Flannery KB, Ronald D Miller: Comparison of Rocuronium, Succinylcholine and vecuroium for rapid sequence induction of anaesthesia in adult patients; *Anaesthesiology*, 1993; 79: 913-918.

[9] Fuchs Buder T and Tassonyi E: Intubating conditions and time course of Rocuronium induced neuromuscular block in children, *British Journal of Anaesthesia*, 1996; 77: 335-338.

[10] Cooper R, Mirakhur RK, Clarke RSJ and Boules Z: Comparison of intubating conditions after administration of Org 9426 (Rocuronium) and Suxamethonium, *British Journal of Anaesthesia*, 1992; 69: 269-273

[11] Huizinga ACT, Vandenbrom RHG, Wierda MKH, Hommu FDM, Hennis PJ: Intubating conditions and onset of neuromuscular block or rocuronium (Org 9426); a comparison with suxamethonium: *Acta Anaeshesiol Scnad*, 1992; 36: 463-468.

[12] Perry JJ, Lee JS, Sillberg VAH, Wells GA. Rocuronium versus Succinylcholine for rapid sequence inducction intubation. *Cochrane Database of Systematic Reviews* 2008, Issue 2, Art No.: CD002788. DOI: 10.1002/14651858. CD002788.pub2.

[13] Aleksandra J Mazurek, Brownyn Rac, Susan Hann, Ikakim J, Barbara Castro, Charles J Cote: Rocuronium versus Succinylcholine: Are they equally effective during rapid sequence indunction of anaesthesia? *Anaesthesia Analgesia*, 1998, 87: 1259-1262.

[14] Shukla Aparna, Dubey KP, Sharma MSN: Comparative evaluation of haemodynamic effects and intubating conditions after the administration of ORG 9426 and Succinylcholine, *Indian Journal of Anaesthesia*, 2004; 48(6): 476-479.

[15] Mark E Hudson, Kenneth P Rothfield, Willian C Tullock, Leonard L. Firestone: Haemodynamic effects of Rocuronium bromide in adult cardiac surgical patients: *Canadian Journal of Anaesthesia*, 1998; 45: 139-43.

[16] Eamon P. McCoy, Venkat R, Maddineni, Peter Elliot, Rajinder K. Mirakhur, Ian W Carson: Haemodynamic effects of Rocuronium during fentanyl anasthesia: Comparison with vecuronium, *Canadian Journal of Anaesthesia*, 1993; 40: 703-8.

[17] Levy, Jerold H, Davis, Gwenk, Duggan, Jane: Determination of haemodynamic and histamine release of Rocuronium when administered in increased doses under nitrous oxide/oxygen sufentanil anaesthesia, *Anaestesia Analgesia*, 1994; 78:318.

[18] Naguib M, Samarkandi AH, Ammar A and Turkistani A: Comparison of Suxamethonium and different combinations of Rocuronium and mivacurium for rapid treacheal intubation in children: *British Journal of Anaesnthesia*, 1997; 79: 450-455.