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A Comparative Study Of Succinylcholine Chloride And Rocuronium Bromide In Adult Patients For Use During Rapid Sequence Intubation

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Abstract

Background:-

Rocuronium bromide is a non-depolarizing muscle relaxant. Rocuronium bromide in its salt preparation is a monoquaternary aminosteroid non-depolarizing skeletal muscle relaxant.

Chemistry [13]

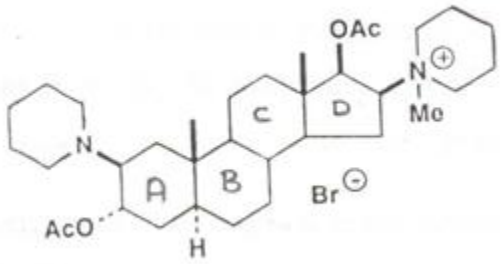

Figure 1: Vecuronium bromide

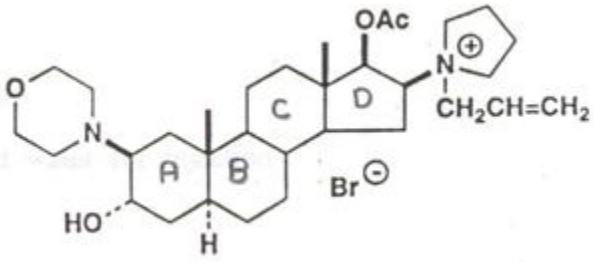

Figure 2: Rocuronium bromide (ORG9426)

Rocuronium bromide differs from vecuronium bromide in three positions.

- having a 2β-morpholino group
- a 3α-hydroxy group

16-pyrrolidino function attached to a 16-N-allyl group

Suxamethonium, diacetylcholine Succinylcholine chloride is a short acting depolarizing skeletal muscle relaxant.

Chemistry [33]

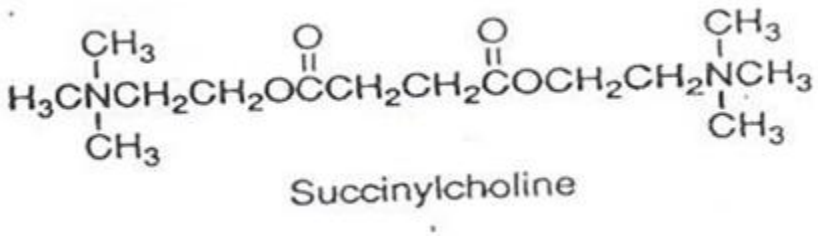

Figure 3: $C_{14}H_{30}Cl_2N_2O_4$

Method

A clinical study comparing rocuronium bromide 0.6 mg kg^{-1} and 0.9 mg kg^{-1} with succinylcholine chloride 1 mg kg^{-1} for use during rapid sequence intubation of anaesthesia in adult patients was undertaken at PGIMS,Rohtak. The study population was randomly divided into three groups with 30 patients in each group.

Group l Consisting of 30 patients were 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 0.6 mg kg^{-1} body weight and intubation attempted at 60 seconds.

Group III Consisting of 30 patients were to receive rocuronium bromide 0.9 mg kg^{-1} body weight and intubation attempted at 60 seconds.

Result

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. 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.

Keywords: NIL

Introduction

Rapid sequence intubation (RSI) is a life saving procedure, developed to secure the airway quickly and safely in life threatening situations. In emergency situations and some other conditions RSI is often chosen over other intubation techniques because simultaneous onset of deep sedation and paralysis, followed by rapid tracheal intubation, minimises the risk of aspiration of gastric contents [(1)]. An ideal neuromuscular blocking agent, to facilitate the tracheal intubation, would provide rapid onset and short but profound effect followed by rapid spontaneous recovery of neuromuscular function.[(2)]

Patients who require tracheal intubation in the emergency department often require a rapid sequence induction (RSI) technique to protect against aspiration of gastric contents, to facilitate intubation, and prevent increased intracranial pressure.[(3),(4)] This involves the rapid administration of a sequence of medications (including a sedative induction anaesthetic and a muscle relaxant, with or without narcotic) followed by endotracheal intubation within one minute of administering a muscle relaxant. In emergency situations, intubation is often required in unstable situations with the potential of haemodynamic instability or a full stomach. This often requires modification of the rapid sequence induction for the individual patient, with the goal of securing a patent airway as safely and quickly as possible.

Succinylcholine, a depolarizing muscle relaxant, is the most common agent used in both the controlled and emergent settings.[(5)] Succinylcholine is the current favourite muscle relaxant because it has a rapid onset of 40 to 60 seconds and a short duration, lasting only 6 to 10 minutes.[(6)] Succinylcholine is contraindicated in patients with major burns (beyond 48 hours), major crush injuries (beyond 48 hours), severe abdominal sepsis, denervation syndromes, and

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major nerve or spinal cord injuries due to the risk of hyperkalaemia as a result of its depolarizing action, possibly leading to fatal cardiac arrhythmia.[7],[8] It is also contraindicated in patients with a history of malignant hyperthermia or previous allergic reaction to succinylcholine.[9]

Alternative agents, among others, include pancuronium, vecuronium, and atracurium; however, none achieve acceptable intubating conditions as rapidly as succinylcholine.[10]

Rocuronium is a steroid based non-depolarizing muscle relaxant, which has been proposed for creating intubating conditions similar to those of succinylcholine. The duration of action is longer, lasting 37 to 72 minutes with standard doses. [11] The only absolute contraindication to rocuronium is allergy. Care must be taken with patients who have myasthenia gravis or myasthenic syndrome, hepatic disease, neuromuscular disease, carcinomatosis or severe cachexia as the duration of action may be profoundly increased. There have been many studies looking at the equivalence of rocuronium and succinylcholine, with conflicting outcomes. It has been suggested that inconsistencies in the use of narcotics, the sedative propofol, or the dose of rocuronium administered may have accounted for these differences.[11]

In this study attempt is made to find a muscle relaxant providing acceptable intubating conditions with minimal haemodynamic effects. 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 1 mg kg^{-1} body weight, for use during rapid sequence intubation of anaesthesia in adult patients.

MATERIALS AND METHODS

A clinical study comparing rocuronium bromide 0.6 mg kg^{-1} and 0.9 mg kg^{-1} with succinylcholine chloride 1 mg kg^{-1} for use during rapid sequence intubation of anaesthesia in adult patients was undertaken at PGIMS,Rohtak

The study population consisted of 90 adult patients of ASA grade I and II belonging to both sexes in the age group of 15 to 60 years who were posted for various elective surgeries at PGIMS,Rohtak. 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 l — Consisting of 30 patients were 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 0.6 mg kg^{-1} body weight and intubation attempted at 60 seconds.

Group III — Consisting of 30 patients were to receive rocuronium bromide 0.9 mg kg^{-1} body weight and intubation attempted at 60 seconds.

In all the three groups of patients, oral endotracheal intubation was attempted at 60 seconds (time noted with stopwatch) following the administration of muscle relaxant and intubating conditions were graded using the score adopted by Toni Magorian et al.[10](1993).

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.

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 and muscle relaxation was maintained with rocuronium.

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

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

OBSERVATIONS

Age distribution

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

Table 1

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	

Sex distribution

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

Table 2

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

Weight distribution

The following table shows the weight distribution of the three groups

Table 3

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	-	-

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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

Intubation Score

(based on the scale adopted by Toni Magorian et al. (1993)[10]

Table 4

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	-	-	-	-	-	-

As it is seen in the table 5, in group I patients who received succinylcholine chloride 1 mg kg^{-1} body weight, all patients (30) had excellent intubating conditions with jaw relaxed, vocal cords apart and immobile and no diaphragmatic movements.

In group II, who received rocuronium bromide 0.6 mg kg^{-1} body weight 16 patients (53.33%) out of 30 had excellent intubating conditions, 13 (43.33%) patients had good intubating conditions with vocal cords apart and immobile and some diaphragmatic movements on intubation. One patient (3.34%) in group II had poor intubating condition with vocal cords moving and bucking after intubation. Even in this patient who had poor intubating condition, intubation was possible at 60 seconds as the jaw was relaxed. Altogether in group II, 96.67% of patients, i.e. 29 patients out of 30 had excellent to good intubating conditions at 60 seconds.

In group III patients, who received rocuronium bromide 0.9 mg kg^{-1} body weight, 29 (96.67%) patients out of 30 had excellent intubating conditions with 1 (3.33%) patient having good intubating condition. There was no case of failed intubation at 60 seconds in any of the three groups.

Duration of action of succinylcholine chloride

Table 5

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 $\pm$ 0.99 minutes	
Maximum duration	8.25 minutes	
Minimum duration	3.5 minutes	

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Duration of action of rocuronium bromide 0.6 mg kg^{-1} body weight

Table 6

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 $\pm$ 2.14 minutes	
Maximum duration	32 minutes	
Minimum duration	22 minutes	

Duration of action of rocuronium bromide 0.9 mg kg^{-1} body weight

Table 7

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 $\pm$ 3.73 minutes	
Maximum duration	52 minutes	
Minimum duration	40 minutes	

Mean Heart rate (beats/min)

Table 8

	Group I Succinylcholine chloride 1 mg kg^{-1}		**Group II Rocuronium bromide 0.6 mg kg^{-1}**		**Group III Rocuronium bromide 0.9 mg kg^{-1}**	
	Beats per minute	**%**	**Beats per minute**	**%**	**Beats per Minute**	**%**
Pre induction	86.20 SD=2.845444		85.97 SD=2.947042		87.43 SD=3.221515	
One minute after intubation	117.30 SD=3.592617	+36.07	118.37 SD=3.518261	+37.69	115.67 SD=3.717	+32.28
Three minute after intubation	104.03 SD=3.26405	+20.68	104.23 SD=3.136914	+ 21.25	102.53 SD=3.350073	+17.27

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Five minute after Intubation	89.83 SD=2.742807	+4.21	89.73 SD=2.875981	+4.38	90.23 SD=3.297683	+3.20

As shown in table, there was a significant ($p < 0.05$) rise in mean heart rate by 36.07%, 37.69% and 32.28% from preinduction 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. There were no abnormal ECG findings noted in any of the cases following the administration of drugs.

Mean Arterial pressure

Table 9

	Group I		**Group II**		**Group III**	
	mm Hg	**%**	**mm Hg**	**%**	**mm Hg**	**%**
Pre induction	90.8 SD=3.47801		90.83 SD=3.494659		92.37 SD=3.408745	
One minute after Intubation	119.17 SD=3.591977	+31.23	121.47 SD=3.339764	+33.72	122.03 SD=3.518261	+31.98
Three minute after intubation	106.30 SD=3.131046	+17.07	108.33 SD=2.98656	+ 19.26	105.10 SD=3.209361	+13.79
Five minute after Intubation	91.23 SD=3.410767	+0.47	95.9 SD=4.045858	+5.58	93.17 SD=3.66421	+0.86

As shown in table, there was a significant ($p < 0.05$) rise in mean arterial pressure by 31.23%, 33.72%, 31.98% from preinduction value at 1 minute following intubation in Group I, Group II, Group III respectively. This rise in mean arterial pressure declined to 0.47%, 5.58%, 0.86% from preinduction value at 5 minutes following intubation. In all three groups, there was a trend towards returning to baseline mean arterial pressure at 5 minute following intubation.

DISCUSSION

The ideal neuromuscular blocking drug should be competitive, non-depolarizing in nature and rapidly acting with relatively short duration of action. Cessation of neuromuscular blockade should not depend on renal and hepatic function should also be highly specific so that no harmful side effects on other systems would occur and last but not least the neuromuscular blockade should be antagonised easily by acetyl cholinesterase inhibitors.

It is hardly surprising that none of the presently available neuromuscular blocking agent can be labelled as ideal as none are fulfilling the above criteria. Thus, the introduction of neuromuscular blocking agents into clinical practice is always of great interest for none of the currently used agents are alike and all possess one or more properties which may be undesirable.

Succinylcholine, with its rapid onset and short duration of action, is mainly used because of its rapid development of good intubating conditions. However, it falls short of the "ideal‘ muscle relaxant due to its numerous side effects. The search for the ideal neuromuscular blocking agent has focused on non-depolarizing agents because most of the side effects of Succinylcholine reflect its depolarizing mechanism of action.

It has been suggested that utilizing a divided-dosage regimen, the priming principle, excellent intubating conditions can be rapidly produced with non-

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depolarizing relaxants alone, thus eliminating the need for Succinylcholine. Rocuronium bromide has a rapid onset of action approximating that of Succinylcholine. This drug could be a replacement of Succinylcholine for intubation and especially for rapid sequence intubation where Succinylcholine is to be avoided.

The purpose of our study was to compare the intubating conditions and haemodynamic effects of Succinylcholine. Rocuronium. In this study an attempt was made to find a muscle relaxant providing acceptable intubating conditions at 60 seconds with minimal haemodynamic effects.

SELECTION OF PATIENTS:

90 adult patients aged 18 to 60 years of either sex undergoing elective surgery under general anaesthesia were studied. All were ASA grade l or ll and none were taking drugs known to interfere with neuromuscular transmission. Patients known or suspected to have neuromuscular disorders, metabolic diseases or impaired renal or hepatic function were excluded from the study. Patients enrolled had either Mallampati class l or ll airway anatomy and showed no contraindications for undergoing rapid sequence induction of anaesthesia.

Selected patients were divided into three groups randomly:

Group I: Patients received Succinylcholine 1mg/kg.

Group II: Patients received Rocuronium 0.6mg/kg.

Group III: Patients received Rocuronium 0.9mg/kg.

Similar selection criteria were used by Baumgerten et al, 1988[14]; Magorian T et al, 1993[10]; Misra MN et al in 2005 [23] and Somboomviboon W et al, 2000[22].

AGE GROUPS:

In our study the age of the patients in the three groups varied from 18 to 60 years Age distribution in the three groups was found to be more or less the same. Mean age in Group I was 34.5 years, in Group II was 30.43 years, and in Group III was 33.03 years.

WEIGHT GROUPS:

The mean weight of patients in Groups I, II, and III were51.34 kg, 54.16 kg and 49.13 kg respectively.

SEX RATIO:

1. In our study Male to female ratio in Group I was 30:70, in Group II 60:40, and in Group III it was 33.34:66.66.

ANAESTHETIC DRUGS USED:

Intubating conditions are influenced by the use of adjuvant drugs such as sedatives and opioids, depth of anaesthesia and induction technique (Stevens JB et al, 1997[24]). To compare the use of different muscle relaxants for rapid sequence induction requires excluding the influence of other anaesthetic agents and judging ease of tracheal intubation by scoring intubatlng conditions (Magorian Toni et al, 1993 [10]).

Patients in our study were premedicated intravenously with lnj.Glycopyrrolate (0.004mg/kg) and lnj.Midazolam (0.04mg/kg). The use of opioids contributes to favourable intubating conditions (Magorian T et al, 1993[10]). Similarly, potent inhalational anaesthetics are known to potentiate the neuromuscular blocking effects of benzylisoquinoline (Wulf H et al, 1998 [25]) and aminosteroid (Bock M et al, 2000 [26]; Rupp M et al, 1984 [15]) neuromuscular blocking agents. Halothane appears to produce less potentiation of neuromuscular block than enflurane and isoflurane (Copper R, 1993 [18]). Thus, in our study, opioid analgesic drugs and inhalational agents that could interfere with breathing or possibly suppress the laryngeal and cough reflex were avoided till the patients were intubated. Mirakhur RK et al, 1986[16], administered no narcotics until after induction while Baumgarten et al, 1988 [14] administered fentanyl during the induction sequence. Similarly no opioid was used by Misra MN et al in his study in 2005 [23].

The choice of induction agent undoubtedly influences intubating conditions (Kansanaho M et al, 1997 [27]; In our study induction was done with Inj.Thiopentone sodium 2.5% with a total mean dose of 5-6mg/kg, before administration of intubating dose of muscle relaxant in all the three groups. No hypnotic agent was given after administration of muscle relaxant which means that the intubating conditions resulted from the neuromuscular block. Thiopentone per se does not affect twitch tension or reliably provide adequate intubating conditions. Propofol and etomidate depress pharyngeal and laryngeal reflexes more than thiopentone sodium (Fuchs-Buder T et al, 1998 [28]; McKeating K et al, 1988 [29]). We selected thiopentone sodium to minimize enhancement of

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muscle relaxation by the induction agent. Thiopentone was used as an induction agent by Mirakhur RK et al. 1985[30]; Misra MN et al 2005 [23]; Baumgarten RK et al, 1988[14] (along with fentanyl); Glass PSA et al,1989[31] (along with fentanyl), and Somboomviboon et al in 2000 [22](along with fentanyl and isoflurane).

Dosage selected

The dosage of the neuromuscular blocking drug selected is usually based on the ED_{95} value. ED_{95} 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 ED_{95} dose.

The ED_{95} dose of succinylcholine chloride is 0.392 mg kg^{-1} body weight. Three times the ED_{95} dose which approximates 1 mg kg^{-1} body weight has been employed for intubation in the present study which is similar to that of Friedrich K. Puhringer et al. 1992 [17], Toni Magorian et al. 1993 [10], C. Wright et al. 1994 [32].

Rocuronium bromide has been employed in two to three times the ED_{95} dose to obtain intubating conditions. The ED_{95} of rocuronium bromide is 0.3 mg kg^{-1} body weight.2 x ED_{95} dose, that is 0.6 mg kg^{-1} of rocuronium bromide has been shown to provide good to excellent intubating conditions at 60 seconds by K.C. McCourt et al. 1998[6], Toni Magorian et al. 1993[10], Friedrich K. Puhringer et al. 1992[17], P. Schultz et al. 2001[33].

3 x ED_{95} dose, that is 0.9 mg kg^{-1} body weight of rocuronium bromide has been shown to provide good to excellent intubating conditions at 60 seconds by Toni Magorian et al. 1993 [10], Fuchs Buder et al. 1996[20], P. Schultz et al. 2001 [33].

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 which is similar to that employed by above authors.

INTUBATION SCORING CRITERIA:

Rapid sequence intubation involves rapid procurement of airway usually at 60 seconds and intubating conditions are scaled at 60 seconds. Intubating conditions 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. The authors who have employed clinical criteria for intubation at 60 seconds are Toni Magorian et al., 1993 [10]; K.C. McCourt et al., 1998 [4]; Friedrich K. Puhringer et al., 1992 [17]; T. Fuchs Buder et al., 1996 [28].In the present study clinical criteria as adopted by Toni Magorian et al. were used instead of neuromuscular monitoring for scaling intubating conditions at 60 seconds.

INTUBATING CONDITIONS:

Various authors have employed succinylcholine chloride 1 mg kg^{-1} body weight and compared its intubating conditions with rocuronium bromide 0.6 mg kg^{-1} body weight and 0.9 mg kg^{-1} body weight. The intubating conditions were judged by clinical criteria and scaled accordingly by various authors.

The intubating conditions with succinylcholine chloride 1 mg kg^{-1} at 60 seconds by various authors and present study is shown below.

Table 11

Authors	Excellent	Good	Poor	Inadequate
1. Cooper et al. 1992 [18] (n=20)	19 (95%)	1 (5%)	-	-
2. Friedrich K. Puhringer et al. 1992 [17] (n = 10)	8 (80%)	1 (10%)	1 (10%)	-
3. Toni Magorian et al. 1993 [10] (n = 10)	8 (80%)	2 (20%)	-	-
4. Naguib M. et al. 1997 [21] (n = 10)	9	1 (10%)	-	-

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	(90%)			
5. K.C. McCourt et al. 1997 [4] (n = 127)	101 (80%)	22 (17%)	4 (3%)	-
6. Present study (n = 30)	30 (100%)	-	-	-

It is noted that with succinylcholine chloride 1 mg kg^{-1} body weight Cooper et al. and Naguib et al. have obtained excellent intubating conditions in 95% and 90% of cases respectively. Only two authors Friedrich K., Puhringer et al 1992 [17]. and K.C. McCourt et al 1998[4]. have noted poor intubating conditions in 10% and 3% respectively. Most of other authors have noted good to excellent intubating conditions in 100% of cases. In the present study also succinylcholine chloride 1 mg kg^{-1} body weight produced excellent intubating conditions in 100% of cases which is comparable with that of Cooper et al. (1992) [18] and Naguib et al. (1992)[21].

Intubating conditions with rocuronium bromide 0.6 mg kg^{-1} body weight at 60 seconds by various authors and present study.

Table 12

Authors	Excellent	Good	Poor	Inadequate
1. Cooper et al. 1992 [18](n=20)	13 (65%)	6 (30%)	1 (5%)	-
2. Friedrich K. Puhringer et al. 1992 [17] (n = 20)	17 (85%)	3 (15%)	-	-
3. Fuchs Buder et al. 1996 [28] (n = 35)	29 (83%)	6 (17%)	-	-
4. Naguib M. et al. 1997 [21] (n = 10)	7 (70%)	3 (30%)	-	-
5. K.C. McCourt et al. 1998[4] (n = 57)	16 (28%)	27 (47%)	14 (25%)	-
6. Present study (n = 30)	16 (53.33%)	13 (43.33%)	1 (3.34%)	-

Thus it is noted from the above table that the incidence of excellent intubating conditions with rocuronium bromide 0.6 mg kg^{-1} body weight ranged from 28% in the study of K.C. McCourt et al. (1998) [4] to 85% in the study of Friedrich K. Puhringer et al. (1992) [17]. The incidence of good intubating conditions ranged from 15% in the study of Friedrich K. Puhringer et al. (1992) [17] to 47% in the study of K.C. McCourt et al. (1998) [4]. Three authors have noted poor intubating conditions with 5% in the study of Cooper et al. (1992) [18] and 25% in the study of K.C. McCourt et al. (1998) [4].

In the present study 16 patients (53.33%) had excellent intubating conditions with rocuronium bromide 0.6 mg kg^{-1} body weight at 60 seconds which concurs with studies of Cooper et al. (1992). 13 patients (43.33%) out of 30 had good intubating conditions which concurs with studies of K.C. McCourt et al. (1998)[4]. Only one patient (3.33%) in the present study had poor intubating condition with jaw relaxed, vocal cords moving and bucking after intubation. However even in this patient intubation was accomplished at 60 seconds. This concurs with study of Cooper et al. (1992)[18].

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Intubating conditions with rocuronium bromide 0.9 mg kg^{-1} body weight at 60 seconds by various authors and present study is shown below.

Table 13

Authors	Excellent	Good	Poor	Inadequate
1. Toni Magorian et al. 1993 [10] (n = 10)	8 (80%)	2 (20%)	-	-
2. Fuchs Buder et al. 1996 [28] (n = 35)	33 (94%)	2 (6%)	-	-
3. Naguib M. et al. 1997 [21] (n = 10)	10 (100%)	-	-	-
4. P. Schultz et al. 2001 [33] (n = 36)[39]	29 (80.5%)	6 (16.67%)	1 (2.78%)	-
5. 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^{-1} body weight ranged from 80% in the study of Toni Magorian et al. (1993) [10] to 100% in the study of Naguib M. et al. (1997)[21]. The incidence of good intubating conditions ranged from 6% in the study of Fuchs Buder et al. (1996) [28] to 20% in the study of Toni Magorian et al. (1993) [10]. Only P. Schultz et al. (2001) [33] 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 0.9 mg kg^{-1} body weight at 60 seconds which concurs with studies of Fuchs Buder et al. (1960) [28]and Naguib M. et al. (1997) [21].

Only 1 patient (3.33%) had good intubating condition which is comparable to the study of Fuchs Buder et al. (1996) [28]. There was no case of poor intubating condition with rocuronium bromide 0.9 mg kg^{-1} body weight.

Comparison of intubating conditions of rocuronium bromide 0.6 mg kg^{-1} body weight with succinylcholine chloride 1 mg kg^{-1} body weight as noted by various authors and present study.

Table 14

Authors	Succinylcholine chloride 1 mg kg^{-1}				Rocuronium bromide 0.6 mg kg^{-1}			
	Excellent	Good	Poor	Inadequate	Excellent	Good	Poor	Inadequate
1. Cooper et al. (1992) [18] (n = 20 each)	19 (95%)	1 (5%)	-	-	13 (65%)	6 (30%)	1 (5%)	-
2. Friedrich K. Puhringer et al. (1992) [17] (n =	8 (80%)	1 (10%)	1 (10%)	-	17 (85%)	3 (15%)	--	-

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10 each)								
3. Naguib M. et al. [21] (n = 10 each)	9 (90%)	1 (10%)	-	-	7 (70%)	3 (30%)	-	-
4. Present study (n = 30 each)	30 (100%)	-	-	-	16 (53.33%)	13 (43.33%)	1 (3.34%)	-

The authors who compared succinylcholine chloride 1 mg kg^{-1} weight with rocuronium bromide 0.6 mg kg^{-1} body weight have noted that both the drugs produce good to excellent intubating conditions at 60 seconds in majority of patients.

In the present study also succinylcholine chloride 1 mg kg^{-1} body weight produced excellent intubating conditions in 100% of patients at 60 seconds. Rocuronium bromide 0.6 mg kg^{-1} body weight produced good to excellent intubating conditions in 96.67% of patients. This concurs with study of Cooper et al. (1992) [18].

Comparison of intubating conditions of rocuronium bromide 0.9 mg kg^{-1} body weight with succinylcholine chloride 1 mg kg^{-1} body weight as noted by various authors and present study.

Table 15

Authors	**Succinylcholine bromide 1 mg kg^{-1}**				**Rocuronium bromide 0.9 mg kg^{-1}**			
	Excellent	**Good**	**Poor**	**Inadequate**	**Excellent**	**Good**	**Poor**	**Inadequate**
1. Toni Magorian et al. (1993) [10] (n = 10 each)	8 (80%)	2 (20%)	-	-	8 (80%)	2 (20%)	-	-
2. Naguib M. et al. (1997) [21] (n = 10 each)	9 (90%)	1 (10%)	-	-	10 (100%)	-	-	-
3. Present study (n = 30 each)	30 (100%)	-	-	-	29 (96.67%)	1 (3.33%)	-	-

The authors who have compared succinylcholine chloride 1 mg kg^{-1} body weight and rocuronium bromide 0.9 mg kg^{-1} 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 mg kg^{-1} body weight produced excellent intubating conditions in 100% of patients. Rocuronium bromide 0.9 mg kg^{-1} 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 Naguib M. et al. (1997) [21].

Comparison of intubating conditions of rocuronium bromide 0.6 mg kg^{-1} body weight and rocuronium bromide 0.9 mg kg^{-1} body weight are noted by various authors and present study.

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Table 16

Authors	Rocuronium bromide 0.6 mg kg^{-1}				Rocuronium bromide 0.9 mg kg^{-1}			
	Excellent	Good	Poor	Inadequate	Excellent	Good	Poor	Inadequate
1. Toni Magorian et al. (1993)[10] (n = 10 each)	10 (100%)	-	-	-	8 (80%)	2 (20%)	-	-
2. Naguib M. et al. (1997)[21] (n=10 each)	7 (70%)	3 (30%)	-	-	10 (100%)	-	-	-
3. Present study	16 (53.33%)	13 (43.33%)	1 (3.34%)	-	29 (96.67%)	1 (3.33%)	-	-

Toni Magorian et al. (1993) [10] observed excellent intubating conditions with rocuronium bromide 0.6 mg kg^{-1} body weight in 100% of patients. With rocuronium bromide 0.9 mg kg^{-1} body weight, they observed excellent intubating conditions in 80% of cases with good intubating conditions in remaining 20% of cases. Naguib M. et al. (1997) [21] observed excellent intubating conditions in 70% of cases and good in 30% of cases with rocuronium bromide 0.6 mg kg^{-1} body weight and with rocuronium bromide 0.9 mg kg^{-1} body weight, they observed excellent intubating conditions in 100% of patients.

In the present study with rocuronium bromide 0.6 mg kg^{-1} body weight, excellent intubating conditions were noted in 53.33% of patients with good intubating conditions in 43.33% of patients. Only one patient (3.33%) had poor intubating condition. With rocuronium bromide 0.9 mg kg^{-1} body weight excellent intubating conditions were noted in 96.67% of cases with good intubating condition in remaining 3.33% of cases. This concurs with studies of Naguib M. et al. (1997)[21].

Naguib M. et al. (1997)[21] compared the intubating conditions of succinylcholine chloride 1 mg kg^{-1} body weight with rocuronium bromide 0.6 mg kg^{-1} body weight and 0.9 mg kg^{-1} body weight for rapid tracheal intubation in children. They observed that succinylcholine chloride 1 mg kg^{-1} body weight produced excellent intubating conditions in 90% of cases and good intubating conditions in remaining 10% of cases. Rocuronium bromide 0.6 mg kg^{-1} body weight produced excellent intubating condition in 70% of cases and good intubating conditions in remaining 30% of cases. Rocuronium bromide 0.9 mg kg-^{1} body weight produced excellent intubating conditions in 100% of cases.

Duration of action

The various authors who have studied rocuronium bromide and succinylcholine chloride have utilized the recovery of twitch height to 25% of baseline as the clinical duration of action. However in the present study the time between the administration of neuromuscular blocking drug and first attempt at respiration was taken as the clinical duration of action.

With rocuronium bromide 0.6 mg kg^{-1} body weight, A.C.J. Huizinga et al. (1992)[3] noted clinical duration to be 24 ± 4 minutes, Cooper et al. (1992)[18] noted a clinical duration of 30.5 ± 7.5 minutes, Fuchs Buder et al. (1996) [28] noted a clinical duration of 21 ± 4 minutes, Naguib M. et al. (1997)[21] noted a clinical duration of 23.7 ± 5.1 minutes and P. Schultz et al. (2001)[33] have noted a mean duration of action of 28.2 minutes noted a clinical duration of action of 30.8 ± 3.17 minutes.

In the present study, the minimum clinical duration for rocuronium bromide 0.6 mg kg^{-1} body weight was

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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. (1997) [21]and P. Schultz et al. (2001) [33] .

Similarly with rocuronium bromide 0.9 mg kg^{-1} body weight R.A. Cooper et al. (1993) [19] noted a clinical duration of action of 58 ± 7.8 minutes, Toni Magorian et al. (1993) [10] noted a clinical duration of action of 53 ± 21 minutes, Naguib M. et al [21] noted a clinical duration of action of 36.4 ± 7.4 minutes and P. Schultz et al. (2001)[33] noted a clinical duration of action of 41.6 minutes.

In the present study, the minimum duration of action for rocuronium bromide 0.9 mg kg^{-1} was 40 minutes maximum duration was 52 minutes with a mean of 45.33 ± 3.73 minutes which concurs with studies of Toni Magorian et al. (1993) [10] and P. Schultz et al. (2001) [33].

Similarly, the clinical duration of succinylcholine chloride 1 mg kg^{-1} body weight in the present study was found to range between a minimum of 3.5 minutes to a maximum of 8.25 minutes with a mean duration of action of 4.773 ± 0.99 minutes which concern with studies of Naguib M. et al. 1997 (4.2 minutes) .

HAEMODYNAMIC EFFECTS:

1. Heart Rate:

Williams CH et al, 1961[34] noticed a moderate increase in heart rate (about 20 b.p.m) after first dose of succinylcholine following thiopentone induction. In our study, a maximum increase of 20.68±3.26405 b.p.m was observed at third minute after intubation with Succinylcholine.

Booth MG et al, 1992 [35] observed a modest increase in heart rate (+36%) white Misra MN et al, 2005 observed a slight tachycardia of 4-5 b.p.m in 63% of patients after 0.6mg/kg dose of Rocuronium. McCoy EP et al, 1993 [11] showed an insignificant increase in heart rate (+7%) with Rocuronium 0.6mg/kg during fentanyl anaesthesia. In our study a highly significant (p<.001) tachycardia i.e. 37.69% and 32.28% was seen with Rocuronium with doses 0.6mg/kg and 0.9mg/kg respectively as no opiod was used for premedication.

Eamon P. McCoy et al. 1993 [11] have demonstrated changes in heart rate (+7%), mean arterial pressure (-5%), systemic vascular resistance (-12%), that were insignificant. They concluded that rocuronium bromide in doses of 0.6 mg kg^{-1} is associated with changes of only small magnitudes in haemodynamic variables.

There was a significant ($p < 0.05$) rise in mean heart rate by 36.07%, 37.69% and 32.28% from preinduction 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.

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. 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 was a response to laryngoscopy and intubation

2. Mean arterial pressure:

There was a significant ($p< 0.05$) rise in mean arterial pressure by 31.23%, 33.72%, 31.98% from preinduction value at 1 minute following intubation in Group I, Group II, Group III respectively. This rise in mean arterial pressure declined to 0.47%, 5.58%, 0.86% from preinduction value at 5 minutes following intubation. In all three groups, there was a trend towards returning to baseline mean arterial pressure at 5 minute following intubation.

This is a normal haemodynamic response to intubation and laryngoscopy due to increased sympathetic stimulation. These results were in agreement with previous study by Abouleish et al, 1994[13] in which significant increase in heart rate and mean arterial pressure were observed coinciding with completion of intubation and skin incision.

Williams CH et al, 1961[34] observed a slight to moderate increase of 5-25 mmHg in systolic and diastolic blood pressure after first dose of Succinylcholine. No significant changes in blood pressure were observed after Rocuronium by Levy JH et al [12], Booth et al [35], Elbaradie Significant et al

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[36], and Misra MN et al [23]. Misra MN et al [23] and Kunjappan VE et al [37] McCoy EP et al [11] observed an insignificant fall in mean arterial blood pressure of (-5%) with Rocuronium 0.6mg/kg and (-7%) with Vecuronium 0.1mg/kg during fentanyl anaesthesia.

In our study, only intubation related significant changes in blood pressure were observed after intubation in all groups. No significant changes in blood pressure were seen 5 minutes after intubation in either group. Thus there were no haemodynamic disturbances following administration of succinylcholine chloride and rocuronium bromide and rise in mean arterial pressure was a response to laryngoscopy and intubation.

SUMMARY AND CONCLUSION

The present study was carried out to compare the intubating conditions and hemodynamic effects of two muscle relaxants namely — Succinylcholine, Rocuronium in context of rapid sequence induction required in elective patients.

Till date, Succinylcholine is considered the gold standard paralytic agent for rapid sequence induction because of its rapid onset and short duration of action. However its use is associated with significant adverse effects and hence is contraindicated in many clinical situations. Thus, there arises a need to find a suitable alternative to Succinylcholine providing acceptable intubating conditions at an interval of 60 seconds with minimum of adverse effects.

The study was conducted on 90 adult patients of ASA Grade I and II in age group of 18-60 years undergoing elective surgery under general anaesthesia in Department of Anaesthesia, PGIMS,Rohtak

On the basis of neuromuscular blocking agent used for tracheal intubation patients were divided into three groups:

Group I Patients were given inj. Succinylcholine 1 mg/kg

Group II Patients were given lnj. Rocuronium 0.6mg/kg

Group III Patients were given lnj. Rocuronium 0.9 mg/kg

All patients were preoperatively assessed and baseline heart rate and blood pressure values were recorded. 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).

All vital parameters were noted preoperatively, before induction, after induction and at 1 min, 3 min, and 5 min interval after intubation.

Following observations were made during the study:

1. The age of the patients in the three groups varied from 18 to 60 years Age distribution in the three groups was found to be more or less the same. Mean age in Group I was 34.5 years, in Group II was 30.43 years, and in Group III was 33.03 years.
2. The mean weight of patients in Groups I, II, and III were51.34 kg, 54.16 kg and 49.13 kg respectively.
3. Male to female ratio in Group I was 30:70, in Group II 60:40, and in Group III it was 33.34:66.66.
4. In group I all patients (30) had excellent intubating conditions. In group II 16 patients (53.33%) out of 30 had excellent intubating conditions, 13 (43.33%) patients had good intubating conditions. One patient (3.34%) in group II had poor intubating condition. Altogether in group III, 96.67% of patients, i.e. 29 patients out of 30 had excellent intubating conditions at 60 seconds.
5. Mean Duration of action of succinylcholine chloride 1 mg/kg body weight, rocuronium bromide 0.6 mg kg^{-1} body weight, rocuronium bromide 0.9 mg kg^{-1} body weight was 4.77 $\pm$ 0.99 minutes, 27.4 $\pm$ 2.14 minutes, 45.33 $\pm$ 3.73 minutes respectively.
6. There was a significant ($p < 0.05$) rise in mean heart rate by 36.07%, 37.69% and 32.28% from preinduction value in Group I, II, III respectively at one minute following intubation.
7. This increase in mean heart rate declined to 4.21%, 4.38% and 3.20% from base line at 5 minutes following intubation.

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8. There was a significant ($p < 0.05$) rise in mean arterial pressure by 31.23%, 33.72%, 31.98% from preinduction value at 1 minute following intubation in Group I, Group II, Group III respectively.
9. This rise in mean arterial pressure declined to 0.47%, 5.58%, 0.86% from preinduction value at 5 minutes following intubation.

In conclusion, 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. 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. 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. 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. 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. 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.

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