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Comparative Study of Rocuronium And Succinylcholine For Rapid Sequence Induction Of Anaesthesia

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Abstract:
Introduction: *Succinylcholine chloride remains Gold standard neuromuscular blocking drug in providing ideal intubating conditions in Rapid sequence intubation. 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.*
Results: *It was noted that succinylcholine chloride 1.5 mg kg-1 body weight produced excellent intubating conditions in 96.67% patients. Rocuronium bromide 0.6 mg kg-1 body weight produced excellent intubating conditions in 60% of patients but produced good intubating conditions in 36.67% of patients. Rocuronium bromide 0.9 mg kg-1 body weight produced excellent intubating conditions in 93.33% 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.*
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.*
Key words: *Anaesthesia; rapid sequence intubation; succinylcholine chloride; rocuronium bromide.*

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I. Introduction

The new Non depolarizing 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 1.5 mg kg^{-1} body weight, for use during rapid sequence intubation of anaesthesia in adult patients.

II. Aim & Objectives

a. To compare the intubating conditions of rocuronium bromide 0.6 mg kg^{-1}, 0.9 mg kg^{-1} body weight with that of succinylcholine chloride 1.5 mg kg^{-1} body weight at 60 seconds.
b. To study the clinical duration of action of rocuronium bromide 0.6 mg kg^{-1}, 0.9 mg kg^{-1} body weight and succinylcholine chloride 1.5 mg kg^{-1} body weight.
c. To study the haemodynamic changes associated with the administration of rocuronium bromide and succinylcholine chloride.

III. Methodology

A clinical study comparing rocuronium bromide 0.6 mg kg^{-1} and 0.9 mg kg^{-1} with succinylcholine chloride 1.5 mg / kg for use during rapid sequence intubation of anaesthesia in adult patients was undertaken at Department of Anaesthesiology,Guntur Medical College,Guntur Dist., during the period from september-2016 to september-2017 after obtaining ethical committee clearance.

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. Informed consent was obtained from the patients before taking up for surgery.

Exclusion Criteria

1) Patients with anticipated difficult airway
2) Modified Mallampati class 3 or 4
3) Pregnancy
4) Hypertension & Diabetes mellitus
5) Bronchial asthma
6) Ischemic heart disease
7) Presence of neuromuscular disease
8) Known allergy to study drugs.

The study population was randomly divided into three groups with 30 patients in each group.
Group I consisting of 30 patients were to receive succinylcholine chloride 1.5 mg 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.

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

On the day of surgery, after the patient had been shifted to the operating room, an intravenous line was secured with an appropriate sized intravenous cannula and the Patient was connected to multichannel monitor. The baseline heart rate, oxygen saturation and electrocardiogram, systolic, diastolic, mean arterial blood pressure and capnography were recorded. Injection Glycopyrrolate 0.2 mg and injection midazolam 1 mg were given intramuscularly to all patients 20-30 minutes prior to administering induction agent. All patients were preoxygenated with 100% oxygen via a face mask for 3 minutes. One minute after Preoxygenation, Injection Fentanyl 1-2 microgram/kg body wt, was given intravenously. They were induced with injection thiopentone sodium 2.5%, 5mg/kg body wt intravenously. In all patients cricoid pressure was applied after the administration of induction agent when the patients become unconscious.

In group I, succinylcholine chloride 1.5 mg kg^{-1} body weight intravenously after the loss of eyelash reflex. Similarly in group II and group III, rocuronium bromide 0.6 mg kg^{-1} and 0.9 mg 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 assessed according to the following criteria.

Assessment of intubating conditions:

A) Laryngoscopy

Easy: Jaw relaxed, no resistance to blade insertion
Fair: Jaw not fully relaxed, slight resistance to blade insertion
Difficult: Poor jaw relaxation, active resistance of the patient to laryngoscopy.

B) Vocal cord position

Abducted
Intermediate / moving
Closed

C) Reaction to insertion of tracheal tube and cuff inflation (diaphragmatic movement or coughing)

None Slight (1 or 2 weak contractions / movement lasting < 5 seconds)
Vigorous / sustained (> 2 contractions or diaphragmatic movement for > 5 seconds). Overall intubating conditions were then classified as Excellent, Good and Poor accordingly:

Table 1

Variable assessed	Excellent (Clinically acceptable)	Good (Clinically acceptable)	Poor (Not clinically acceptable)
Laryngoscopy	Easy	Fair	Difficult
Vocal cord position	Abducted	Intermediate or moving	Closed
Reaction to insertion of tracheal tube and cuff inflation	None	Slight	Vigorous or sustained

All three parameters were taken into consideration for assessing overall intubating conditions. Thus the final assessment was considered.,

"Excellent" if all parameters were judged excellent
"Good" if one or more parameters were good and none were rated poor
"Poor" if any of the parameters was rated poor

All the patients were intubated with well lubricated appropriate sized oral PVC cuffed endotracheal tubes, cuff inflated, bilateral air entry was checked and the tube was firmly secured. No noxious stimulus was allowed during study period of intubation. Maintainance of anaesthesia was done with 40% oxygen & 60% nitrous oxide, inhalational anesthetic agent and IPPV. Monitoring of vital parameters like heart rate, oxygen saturation, electrocardiogram (Lead II), systolic, diastolic and mean arterial blood pressures 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 initial bolus doses of succinylcholine chloride and rocuronium bromide was noted. Subsequently, the muscle relaxation was maintained with subsequent doses of NDMRs till the end of surgery.

At the end of surgery all the patients were reversed with injection neostigmine 0.05mg/kg body weight and injection glycopyrrolate 0.01 mg / kg body wt. When extubation criteria met patients were extubated. After extubation pts were oxygenated with 100% oxygen for 5 min & shifted to post operative ward.
At the end of the study all the results were grouped, compared & analysed statistically by using student t-test, ANOVA test and Bonferroni Posthoc test.

IV. Results

Demographic data:
Age distribution;
Patients in all the 3 groups were comparable with respect to age. (Table-5) Data were compared using analysis of variance (ANOVA test).There was no statistical difference between the groups and the P value was 0.112.

Onset of action in seconds;

Patients in all the 3 groups were comparable with respect to onset of action. (Table-8) Data were compared using ANOVA & Bonferroni Post Hoc test. The onset of action was noted to be statistically significant between the 3 groups ($P<0.05$).

Table 2

Group		Onset of action in seconds, Mean	SD
I	(n=30)	48.83	± 5.62
II	(n=30)	55.96	± 9.46
III	(n=30)	51.76	± 8.25

Intubating Conditions;
Patients in all the 3 groups were comparable with resptect to intubation conditions

Table 3

Intubating Condition	Group I (n = 30)		Group II (n = 30)		Group III (n = 30)	
	No. of patients	%	No. of patients	%	No. of patients	%
Excellent	29	96.67	18	60	28	93.33
Good	1	3.33	11	36.67	2	6.67
Poor	-	-	1	3.33	-	-

As it is seen in the table, in group I patients who received succinylcholine chloride 1.5 mg kg^{-1} body weight, 29 patients (96.67%) out of 30 had excellent intubating conditions and one patient (3.33%) out of 30 had good intubating condition.

In group II, who received rocuronium bromide 0.6 mg kg^{-1} body weight 18 patients (60%) out of 30 had excellent intubating conditions, 11 (36.67%) patients had good intubating conditions. One patient (3.34%) in group II had poor intubating condition with vocal cords moving and vigorous reaction to insertion of tracheal tube. In group III patients, who received rocuronium bromide 0.9 mg kg^{-1} body weight 28 (93.37%) patients out of 30 had excellent intubating conditions and 2 (6.67%) patients having good intubating conditions.

Duration of action in minutes;

Patients in all the 3 groups were comparable with respect to duration of action of neuromuscular blocking agents. Using the ANOVA test, Bonferroni Post Hoc test the duration of action was noted to be statistically significant between the 3 groups, with a P value of <0.05.

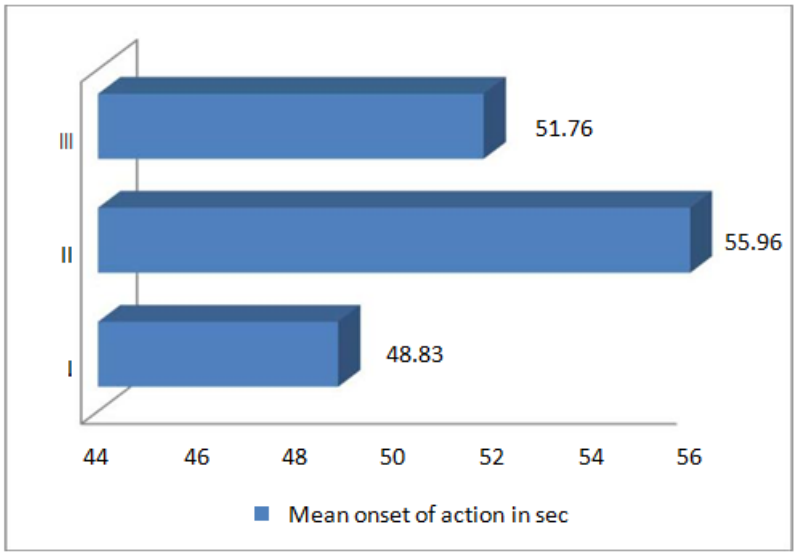
Table 4

	Succinylcholine 1.5mg/kg	Rocuronium 0.6mg/kg	Rocuronium 0.9mg/kg	P-value
Duration of action in min Range	3-7	22-31	40-51	< 0.05
Mean+SD	4.75± 1.02	26.71± 1.98	45.09± 2.66	

Bonferroni posthoc analysis (significant)

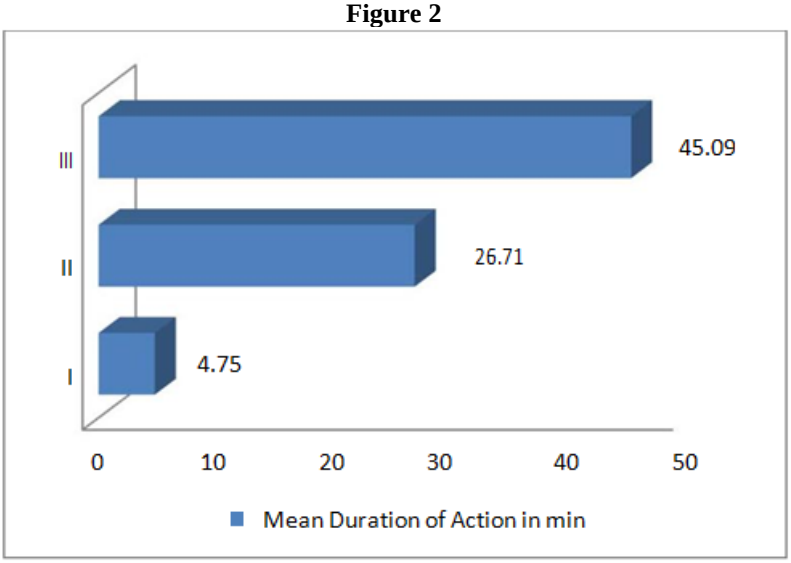
Mean onset of action in sec

Figure – 1



Mean duration of action in min

Figure 2



Mean Heart Rate;

Table 5

	Group I Succinylcholine chloride1.5mg/kg		Group II Rocuronium bromide 0.6 mg/kg		Group III Rocuronium bromide 0.9 mg/kg	
	Beats per minute	%	Beats per minute	%	Beats per minute	%
Preinduction	83.97 SD±8.38		85.77 SD±8.53		85.47 SD± 9.53	
One minute after intubation	113.8 SD±10.53	+35.37	115.53 SD± 8.64	+34.12	113.73 SD± 8.32	+30.36
Three minute after intubation	101.77 SD±8.80	+19.02	104.37 SD±7.85	+ 20.96	101.27 SD± 7.84	+18.10
Five minute After intubation	87.40 SD±8.65	+3.92	89.83 SD±7.67	+4.12	89.93 SD±7.57	+3.19

As shown in table, there was a significant ($p < 0.05$) rise in mean heart rate by 35.37%, 34.12% and 30.36% from basal value w i t h in Group I, II, III respectively. This increase in mean heart rate declined to 3.92%, 4.12% and 3.19% 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 6

	Group I		Group II		Group III	
	mm Hg	%	mm Hg	%	mm Hg	%
Preinduction	93.13 SD±6.52		91.37 SD±6.88		92.73 SD±6.11	
One minute After intubation	119.87 SD±9.92	+29.34	122.33 SD±8.95	+34.13	122.53 SD±6.96	+32.82
Three minute after intubation	106.87 SD±8.178	+16.29	110.7 SD±9.78	+ 20.12	106.10 SD±8.02	+14.82
Five minute After intubation	93.17 SD±9.11	+1.38	98.93 SD±8.48	+4.97	93.07 SD±5.19	+1.12

As shown in table, there was a significant ($p < 0.05$) rise in mean arterial pressure by 29.34%, 34.13%, 32.82% from basal value at 1 minute following intubation in Group I, Group II, Group III respectively. This rise in mean arterial pressure declined to 1.38%, 4.97%, 1.12% from basal 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.

V. Discussion

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 intragastric, intraocular and intracranial pressure started surfacing, quest began for better relaxants devoid of these adverse effects. Many drugs like vecuronium, atracurium and mivacurium were introduced into clinical practice, but none could challenge succinylcholine chloride in terms of onset time.

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.

Dosage selected

The ED95 dose of succinylcholine chloride is 0.392 mg kg^{-1} body weight. Four times the ED95 dose which approximates 1.5 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 intubating conditions. The ED95 of rocuronium bromide is 0.3 mg kg^{-1} body weight. 2 x ED95 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[1]. 1998, Toni Magorian et al[2]. 1993, Friedrich K. Puhringer et al[3]. 1992, and Misra MN et al[4].2005. 3 x ED95 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[2]. 1993, Fuchs Buder et al[5], and Cheng CA et al[6]. 2002.

Hence in our study rocuronium bromide has been employed in two doses, i.e. 0.6mg kg^{-1} body weight and 0.9 mg kg^{-1} body weight which is similar to that employed by above authors.

Onset of action

In the present study onset of action of neuromuscular blocking agents was assessed by clinical methods, which depended on the onset of apnoea and cessation of chest movements. The mean time for onset of action of succinylcholine 1.5mg/kg was 48.83±5.62 s which were close to , Magorian et al[7] (50±17 s) and Misra MN et al [4](46.69±14.78 s). Rocuronium with 0.6mg/kg body wt had shown the mean onset of action to be 55.96±9.46 s which were close to Misra MN et al[4] study (53.67±11.87 s) . Rocuronium with 0.9mg/kg body wt had shown mean onset of action of 51.76±8.25 s which is consistent with the results of Cooper et al[8], 45-59 s depending upon the dose (0.5-0.9 mg/kg body wt).

Intubating conditions

The intubating conditions with succinylcholine chloride 1.5 mg kg^{-1} at 60 seconds

Various authors like Cooper et al[8] have obtained excellent intubating conditions in 95% and 90% of cases with succinylcholine chloride 1mg/kg body wt. Most of the authors have noted good to excellent intubating conditions in 100% of cases.In the present study also succinylcholine chloride 1.5 mg kg^{-1} body weight produced excellent intubating conditions in 29 patients (96.67%) out of 30 cases and only one patient (3.33%) had good intubating condition which is comparable with that of Cooper et al[8]. (1992) and Naguib et al[9]. (1997).

Intubating conditions with rocuronium bromide 0.6 mg kg^{-1} body weight at 60seconds

In the present study 18 patients (60%) out of 30 had excellent intubating conditions with Rocuronium bromide 0.6 mg/kg body wt at 60 seconds which were close with studies of Cooper et al[8].(1992) and Aparna shukla et al[10].(2004). 11 patients (36.67%) out of 30 had good intubating conditions which were close with studies Cooper et al[8]. Only one patient (3.33%) in the present study had poor intubating condition with vocal cords moving and vigorous reaction to insertion of trachel tube. However even in this patient intubation was accomplished at 60 seconds.

Intubating conditions with rocuronium bromide 0.9mg/kg body weight at 60 s

In the present study 93.33% of patients had excellent intubating conditions with Rocuronium bromide 0.9 mg/kg body weight at 60 seconds which were close with studies of Fuchs Buder et al[5].(1996) and Naguib M.et al[9].(1997). Only 2 patients (6.67%) had good intubating condition which is comparable to the study of Fuchs Buder et al[5]. (1996). There was no case of poor intubating condition with rocuronium bromide 0.9 mg kg^{-1} body wt.

Comparison of intubating conditions of rocuronium bromide 0.6 mg/ kg body weight with succinylcholine chloride 1.5 mg kg^{-1} body weight.

Table 7

Authors	Succinylcholine chloride 1.5 mg kg^{-1}			Rocuronium bromide 0.6 mg kg^{-1}		
	Excellent	Good	Poor	Excellent	Good	Poor
1. Cooper et al. (1992) (n = 20 each)	19 (95%)	1 (5%)	-	13 (65%)	6 (30%)	1 (5%)
2. Friedrich K. Puhringer et al. (1992) (n = 10 each)	8 (80%)	1 (10%)	1 (10%)	17 (85%)	3 (15%)	--
3. Naguib M. et al. (n = 10 each)	9 (90%)	1 (10%)	-	7 (70%)	3 (30%)	-
4. Present study (n = 30 each)	29 (96.67%)	1 (3.33 %)	-	18 (60%)	11 (36.67%)	1 (3.33%)

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 1.5 mg kg^{-1} body weight produced excellent intubating conditions in 96.67% of patients at 60 seconds. Rocuronium bromide 0.6 mg kg^{-1} body weight produced excellent intubating conditions in 60% of patients, good intubating conditions in 36.67% of patients and poor intubating conditions in 3.33% of patients. This results were close with study of Cooper et al[8]. (1992).

Comparison of intubating conditions of rocuronium bromide 0.9 mg / kg body weight with succinylcholine chloride 1.5 mg kg^{-1} body weight.

Table 8

Authors	Succinylcholine bromide 1.5 mg kg^{-1}			Rocuronium bromide 0.9 mg kg^{-1}		
	Excellent	Good	Poor	Excellent	Good	Poor
1. Toni Magorian et al. (1993) (n = 10 each)	8 (80%)	2 (20 %)	-	8 (80%)	2 (20%)	-
2. Naguib M. et al. (1997) (n = 10 each)	9 (90%)	1 (10 %)	-	10 (100%)	-	-
3. Present study (n = 30 each)	29 (96.67%)	1 (3.33 %)	-	28 (93.33%)	2 (6.67%)	-

In the present study succinylcholine chloride 1.5 mg kg^{-1} body weight produced excellent intubating conditions in 29 patients (96.67%) out of 30 patients and only one patient (3.33%) had good intubating condition. Rocuronium bromide 0.9 mg kg^{-1} body wt produced excellent intubating conditions in 28 out of 30 patients (93.33%) which were close with studies of Naguib M. et al[9]. (1997) and 2 out 30 patients (6.67%) shows good intubating conditions.

Comparison of intubating conditions of rocuronium bromide 0.6 mg / kg body weight and rocuronium bromide 0.9 mg / kg body weight

In the present study with rocuronium bromide 0.6 mg kg^{-1} body weight, excellent intubating conditions were noted in 60% of patients with good intubating conditions in 36.67% 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 2 8 c a s e s (93.33%) with good intubating condition in t w o c a s e s (6.67%) out of 30 cases. This results were close with studies of Naguib M. et al[9]. (1997).

Comparison of intubating conditions of rocuronium bromide 0.6 mg kg^{-1} body weight and rocuronium bromide 0.9 mg kg^{-1} body weight with succinylcholine chloride 1.5 mg kg^{-1} body weight as noted by various authors and present study.

Table 9

Authors	Succinylcholine chloride 1.5 mg kg^{-1}			Rocuronium bromide 0.6 mg kg^{-1}			Rocuronium bromide 0.9 mg kg^{-1}		
	Excellent	Good	Poor	Excellent	Good	Poor	Excellent	Good	Poor
1. Toni Magorian et al. (1993) (n = 10 each)	8 (80%)	2 (20%)	-	10 (100%)	-	-	8 (80%)	2 (20%)	-
2. Naguib M. et al. (1997) (n = 10 each)	9 (90%)	1 (10%)	-	7 (70%)	3 (30%)	-	10 (100%)	-	-
3. Present study (n = 30 each)	29 (96.67%)	1 (3.33%)	-	18 (60%)	11 (36.67%)	1 (3.33%)	28 (93.33%)	2 (6.67%)	-

The present study involved comparison of Succinylcholine 1.5 mg/kg body weight with rocuronium bromide 0.6 mg kg^{-1} body weight and 0.9 mg kg^{-1} body weight for rapid sequence intubation in adult patients. It was noted that succinylcholine chloride 1.5 mg/kg body wt produced excellent intubating conditions in 96.67% of patients. Rocuronium bromide 0.6 mg kg^{-1} body weight produced excellent intubating conditions in 60% of cases, good intubating conditions in 36.67% and poor intubating conditions in 3.33% of cases. Rocuronium bromide 0.9 mg kg^{-1} body weight produced excellent intubating conditions in 93.33% of cases and good intubating conditions in 6.67% of cases. Thus increasing the dose of rocuronium bromide from 0.6 mg kg^{-1} to 0.9 mg kg^{-1} body wt increased the incidence of excellent intubating conditions but at the cost of increased duration of action. The present study is comparable with study of Naguib M. et al[9]. (1997).

Untoward side effects

In the present study no significant side effects were observed during laryngoscopy and intubation, however non significant complications like arrhythmias appear in some patients and they were likely to be due to adrenergic responses during laryngoscopy and intubation, rather than to the effect of drugs.

VI. Conclusion

1. Succinylcholine chloride 1.5 mg kg-1 body weight produces clinically acceptable, excellent intubating conditions in 96.67% of patients at 60 seconds and with a mean clinical duration of action of 4.75 ± 1.02 minutes.
2. Rocuronium bromide 0.6 mg kg-1 body weight produces excellent intubating conditions in 60% of patients at 60 seconds and with a mean clinical duration of action of 26.71 ± 1.98 minutes.
3. Rocuronium bromide 0.9 mg kg-1 body weight produces clinically acceptable, excellent intubating conditions in 93.33% of patients at 60 seconds and with a mean clinical duration of action of 45.09 ± 2.66 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 clinically acceptable, excellent intubating conditions but at the cost of increased duration of action.
5. succinylcholine chloride with its rapid termination of action (3-7min) is a safer agent for use in patients

with anticipated difficulty in intubation and Rocuronium bromide is a safe alternative to succinylcholine chloride for rapid sequence induction of anaesthesia in situations where succinylcholine is contraindicated and in whom there is no anticipated difficult airway.

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