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Comparison of Rocuronium Bromide and Succinylcholine Chloride for Use during Rapid Sequence Intubation in Adult Patients

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Abstract:
The goal of rapid sequence intubation is to secure the patients airway smoothly and quickly, minimizing the chances of regurgitation and aspiration of gastric contents. Traditionally succinylcholine chloride has been the neuromuscular blocking drug of choice for use in rapid sequence intubation because of its rapid onset of action and profound relaxation. Succinylcholine chloride remains unsurpassed in providing ideal intubating conditions. However the use of succinylcholine chloride is associated with many side effects like muscle pain, bradycardia, hyperkalaemia and rise in intra gastric and intraocular pressure. Rocuronium Bromide is the only drug currently available which has the rapidity of onset of action like succinylcholine chloride. Hence the present study was undertaken to compare Rocuronium Bromide with Succinyl Choline chloride for use during rapid sequence intubation in adult patients

Methodology: *The study population consisted of 90 patients aged between 18-60 years posted for various elective surgeries requiring general anaesthesia at Sri Venkateswara Medical College , Tirupati study population was randomly divided into 2 groups with 30 patients in each sub group.*
1. Group I: Intubated with Succinylcholine chloride 1 mg kg-1 (n = 30)
2. Group II: Intubated with Rocuronium bromide 0.9 mg kg-1 (n = 30)
Intubating conditions were assessed at 60 seconds based on the scale adopted by Toni Magorian et al. 1993. The haemodynamic parameters in the present study were compared using p-value obtained from student t-test.

Results: *It was noted that succinylcholine chloride 1 mg kg-1 body weight produced excellent intubating conditions in all patients. Rocuronium bromide 0.9 mg kg-1 body weight produced excellent intubating conditions in 96.67% of patients, which was comparable to that of succinylcholine chloride.*

Interpetation and Conclusion: *Thus, from the present study, it is clear that succinylcholine chloride is the drug of choice for rapid sequence intubation. Rocuronium bromide is a safe alternative to succinylcholine chloride in conditions where succinylcholine chloride is contraindicated and in whom there is no anticipated difficult airway.*

Keywords: *Anaesthesia; rapid sequence intubation; Succinyl Choline chloride; Rocuronium bromide*

I. Introduction

Anaesthesia defined as 'a defect of sensation', first appeared in Bailey's English Dictionary in 1751. Inventions and discoveries started rolling down in the field of anaesthesia when W.T.G. Morton demonstrated the effects of Diethyl ether to the world.

With the introduction of endotracheal anaesthesia during World War I and balanced anaesthesia in 1926, a search began for a drug which could cause jaw relaxation to facilitate endotracheal intubation. Most of the intubations were done with inhalational technique which was associated with problems like laryngospasm, bronchospasm. Further there was a need to take the patient sufficiently deep before intubation which lead to haemodynamic disturbances[1].

Succinylcholine chloride, introduced in 1951, was a synthetic depolarizing muscle relaxant. It fulfilled both of the above requirements, and soon became the drug of choice for endotracheal intubation especially in rapid sequence intubation in emergency cases. But all did not go well for succinylcholine chloride when its adverse effects started surfacing especially Hyperkalemia, rise in intra gastric, intraocular, intracranial pressures and cardiovascular effects. Thus the quest began for a safer substitute for succinylcholine chloride

The aim of research on neuromuscular drugs was to have non depolarising muscle relaxant, which is like succinylcholine chloride without its side effects. Though many NDMR drugs like Atracurium besylate,

Vecuronium bromide and Mivacurium chloride were introduced, none of them could challenge succinylcholine chloride in terms of its onset. The new NDMR 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 0.9 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.

II. Materials & Methods

A clinical study comparing Rocuronium bromide 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 Sri Venkateswara Medical College, Tirupati, during the period from 01-03-2019 to 03-03-2020 after obtaining ethical committee clearance.

The study population consisted of 60 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 at Sri Venkateswara Medical College Informed consent was obtained from the patients before taking up for surgery. Exclusion criteria consisted of patients with hypertension, diabetes, bronchial asthma, ischaemic heart disease or anticipated difficult airway.

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

Group I consisting of 30 patients received succinylcholine chloride 1 mg kg-1 body weight and intubation attempted at 60 seconds.

Group II consisting of 30 patients were to receive Rocuronium bromide 0.9 mg kg-1 body weight and intubation attempted at 60 seconds.

A thorough pre anaesthetic evaluation was dose 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 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 consisting of pulse oximeter, electrocardiogram, heart rate, non-invasive blood pressure and Capnography.

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

The baseline heart rate, oxygen saturation and electrocardiogram, systolic, diastolic, mean arterial blood pressure and capnography were recorded Injection. Glycopyrolate 0.2 mg and Injection. Midazolam 1 mg were given to all patients 3 minutes prior to administering induction agent.

All patients were pre oxygenated with 100% oxygen via a face mask for 3 minutes after administering glycopyrolate and midazolam. They were induced with injection Thiopentone sodium 5 mg kg-1 body weight intraveously.

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

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

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

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

All the patients were intubated with well lubricated appropriate sized oral red rubber endotracheal tubes (cuffed), bilateral air entry was checked and the tube was firmly secured.

Maintenance of anaesthesia was done with 30% oxygen and 70% nitrous oxide and CMV

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

The clinical duration of action that is the time from administration of relaxant tofirst attempt at respiration of initial bolus doses of succinylcholine chloride and rocuronium bromide was noted. Subsequently, the muscle relaxation was maintained with vecuronium bromide 0.04 mg kg-1 body weight till the end of surgery because we had limited stock of rocuronium.

At the end of surgery all the patients were reversed with injection neostigmine 0.05 mg kg-1 body weight and injection glycopyrolate 0.2 mg kg-1 body weight.

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

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

III. Results

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

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

Intubation Score

Based on the scale adopted by Toni Magorian et al. (1993)[3]

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

In group I patients who received succinyl choline 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 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.

Mean Heart rate (beats/min)

	Group I Succinylcholine chloride 1mg kg $^{-1}$		Group II Rocuronium bromide 0.9mg kg $^{-1}$	
	Beats per minute	%	Beats per minute	%
Pre induction	86.20 SD=9.539 SEm=1.742		87.43 SD=10.109 SEm=1.846	
One minute after intubation	117.30 SD=11.721 SEm=2.140	+36.07	115.67 SD=8.770 SEm=1.601	+32.28
Three minute after intubation	104.03 SD=10.156 SEm=1.854	+20.68	102.53 SD=8.513 SEm=1.554	+17.27
Five minute after intubation	89.83 SD=9.374 SEm=1.711	+4.21	90.23 SD=8.003 SEm=1.461	+3.20

As shown in table, there was a significant ($p < 0.05$) rise in mean heart rate by 36.07% and 32.28% from pre induction value in Group I, II respectively. This increase in mean heart rate declined to 4.21% 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

	Group I		Group III	
	mm Hg	%	mm Hg	%
Pre induction	90.8 SD=7.654 SEm=1.397		92.37 SD=6.557 SEm=1.197	
One minute after Intubation	119.17 SD=11.216 SEm=2.048	+31.23	122.03 SD=7.912 SEm=1.469	+31.98
Three minute after intubation	106.30 SD=8.979 SEm=1.639	+17.07	105.10 SD=8.470 SEm=1.546	+13.79
Five minute after Intubation	91.23 SD=11.041 SEm=2.016	+0.47	93.17 SD=5.908 SEm=1.079	+0.86

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

IV. Discussion

Endotracheal intubation offers safe conduct of general anaesthesia. Though other methods of securing the airway are available today, nothing can match the safety of endotracheal tube in firmly securing the airway. Prior to the introduction of muscle relaxants, inhalational agents were used for endotracheal intubation. Inhalational technique was associated with its own complications when intubation was attempted with inadequate depth. The complications noted were laryngospasm and bronchospasm.

The dosage of the neuromuscular blocking drug selected is usually based on the ED95 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.

Further one more method is available with non-depolarizing muscles relaxants and that is priming in which one tenth the ED95 dose is administered followed by the full dose. This hastens the onset of neuromuscular blockade. But it is associated with discomfort to the patient like choking sensation in the throat, unpleasant symptoms of weakness and double vision. Thus employing single bolus dose in multiples of ED95 is a better technique of obtaining adequate relaxation than priming method for hastening the onset of action.36

The ED95 dose of succinylcholine chloride is 0.392 mg kg-1 body weight. Three times the ED95 dose which approximates 1 mg kg-1 body weight has been employed for intubation in the present study which is similar to that of Friedrich K. Puhringer et al. 1992, Toni Magorian et al. 1993, C. Wright et al. 1994.[2,3]

Three times the ED95 dose which approximates, i.e 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, Fuchs Buder et al. 1996, P. Schultz et al. 2001.[4,5]

Hence in our study succinylcholine chloride 1mg kg -1 rocuronium bromide has been employed 0.9 mg kg-1 body weight which is similar to that employed by above authors.

Various authors have employed neuromuscular monitoring for assessing the time for intubation. They have defined the onset time as the time from injection of drug to 95% twitch height depression. The authors who have employed neuromuscular monitoring in comparing rocuronium bromide and succinylcholine chloride are Friedrich K. Puhringer et al., 1992; Cooper R.A. et al., 1993; C. Wright et al., 1994. However, with non-depolarizing muscle relaxant like rocuronium bromide it has been found that the onset of paralysis at laryngeal muscles preceeded that at adductor pollicis and hence monitoring of train of four at adductor pollicis may not give the correct picture of intubating conditions.[6]

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; K.C. McCourt et al., 1998; Friedrich K. Puhringer et al., 1992; T. Fuchs Buder et al., 1996; Aparna Shukla et al., 2004.[7,8]

Hence in the present study clinical criteria as adopted by Toni Magorian et al. were used instead of neuromuscular monitoring for scaling intubating.

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

Authors	Excellent	Good	Poor	Inadequate
1.cooper et al.1992 (n-20)	19 (95%)	1 (5%)	-	-
2. Friedrich K. Puhringer et al. 1992 (n = 10)	8 (80%)	1 (10%)	1 (10%)	-
3. Toni Magorian et al. 1993 (n = 10)	8 (80%)	2 (20%)	-	-
4. Naguib M. et al. 1997 (n = 10)	9 (90%)	1 (10%)	-	-
5. K.C. McCourt et al. 1997 (n = 127)	101 (80%)	22 (17%)	4 (3%)	-
6. Present study (n = 30)	30 (100%)	-	-	-

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) to 100% in the study of Naguib M. et al. (1997). 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 Magorian et al. (1993). Only P. Schultz et al. (2001) noted the incidence of poor intubating condition in 1 (2.78%) patient.[9] 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. (19960 and Naguib M. et al. (1997).[10]

	Succinylcholine chloride 1mg kg $^{-1}$				Rocuronium bromide 0.9 mgkg $^{-1}$			
	Excellent	Good	Poor	inadequate	Excellent	Good	Poor	inadequate
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)	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)**.**[10]

The cardiovascular changes following the administration of rocuronium bromide have been studied by Eamon P. McCoy et al. 1993 and Mark E. Hudson et al. 1998.

Eamon P. McCoy et al. 1993 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.[11]

Mark E. Hudson et al. 1998 measured the haemodynamic effects of rocuronium bromide in adults undergoing cardiac surgery with cardiopulmonary bypass. rocuronium bromide had no effect on pulmonary capillary wedge pressure, systemic vascular resistance, mean arterial pressure and cardiac index. Thus rocuronium bromide has been demonstrated to be haemodynamically a stable drug.[12]

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

Similar trends were seen following the administration of succinylcholine chloride 1 mg kg-1 body weight. There was a rise in mean heart rate by 36.07% from pre induction value one minute after intubation.

There was also a rise in mean arterial pressure by 31.23% from pre induction value one minute after intubation. These values returned towards pre induction values 5 minutes following intubation.

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

Levy and Jerrold H. et al. 1993 have demonstrated no increase in plasma histamine levels at 1, 3 and 5 minute after the rapid iv bolus of 0.6, 0.9, 1.2 mg kg-1 body weight rocuronium bromide. [13]

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

V. Conclusion

1. Succinylcholine chloride 1 mg kg-1 body weight produces excellent intubating conditions in all the patients at 60 seconds with an average clinical duration of action of 4.77 ± 0.99 minutes.
2. Rocuronium bromide 0.9 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.
3. Rocuronium bromide is a safe alternative to succinylcholine chloride for rapid sequence induction in adult patients in situations where succinylcholine is contraindicated and in whom there is no anticipated difficult airway.

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