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A Comparative Study of Rocuronium and Succinylcholine for Rapid Sequence Induction of Anaesthesia

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ABSTRACT

Rocuronium bromide introduced in 1994 was a non depolarizing muscle relaxant which became the first competitor to succinylcholine by producing excellent to good intubating conditions at 60 seconds. It had an intermediate duration of action with minimal hemodynamic changes and no histamine release. Also, it was devoid of the adverse effects seen with succinylcholine. The present study was undertaken to evaluate the efficacy of two different doses of Rocuronium bromide in comparison to Succinylcholine for use during rapid sequence induction of anaesthesia. Ninety patients posted for elective surgeries were divided into groups of 30 each randomly. Group S received Succinylcholine 1.5 mg/kg and Group R8 received Rocuronium bromide 0.8 mg/kg. Laryngoscopy and intubation was done at 60 seconds after assessing the relaxation of jaw, vocal cords status and response to intubation using a standard intubation scoring system by a double blinded assessor. Results were tabulated and analyzed using appropriate statistical methods. Excellent intubating conditions were seen in 100% of Group S and 88% in Group R8 respectively. Rocuronium 0.8 mg/kg also had a shorter duration of action compared to the usual high dose (0.9-1.2 mg/kg) given in rapid sequence induction of anaesthesia. Hemodynamic changes returned to pre-induction baseline values by the end of 5 minutes in both groups Hence we concluded that Rocuronium bromide was a safer and a good alternative to Succinylcholine for rapid sequence induction of anaesthesia in adult patients where Succinylcholine was contraindicated provided that there was no anticipated difficulty in intubation.

INTRODUCTION

Rapid sequence induction is the technique of choice in emergency situations in the presence of full stomach to prevent aspiration of gastric contents and thereby protect the airway minimizing the chance of regurgitation after induction of anaesthesia. The ideal neuromuscular blocking agent for this should have a fast onset, brief duration of action and provide profound relaxation free from hemodynamic changes. [(1)] Traditionally, succinylcholine has been the gold standard neuromuscular blocking drug of choice

for rapid sequence induction anaesthesia. However, it was associated with many side effects like bradycardia, hyperkalemia, myalgia, increased intraocular and intragastic pressures. It is also contraindicated in certain conditions like burns, neuromuscular diseases which may trigger malignant hyperthermia. Rocuronium bromide has a more rapid onset of action compared to other non depolarizing muscle relaxants. Hence the present study was undertaken to determine the efficacy of rocuronium bromide 0.8 mg/kg in comparison with succinylcholine 1.5 mg/kg for rapid sequence induction in adult patients by comparing the intubating conditions, the clinical duration of action, the hemodynamic changes and the side effects. A technique mimicking rapid sequence induction was followed in these patients.

METHODOLOGY

After obtaining the approval of the institutional ethical committee and a written informed consent from the patients, 50 patients of ASA PS I and II posted for elective surgeries requiring general anaesthesia, aged between 20 to 60 years of either sex, were randomly to divided into two groups of 25 each by sealed envelope technique after a thorough preanaesthetic evaluation. The exclusion criteria consisted of patients with comorbid conditions like ischemic heart disease, hypertension, diabetes mellitus, bronchial asthma, neurological diseases, myopathies, burns, abnormal serum electrolytes, family history of allergy and malignant hyperthermia and those taking drugs which might interact with the study drugs. Also patients with anticipated difficult airway were excluded.

On the day of surgery, a good intravenous (IV) line was established with an appropriate sizes IV cannula and an IV fluid was started. A multi-channel monitor consisting of pulse oximeter, electrocardiogram, heart rate, non-invasive blood pressure and capnography was connected. The baseline pre-induction heart rate, oxygen saturation, systolic, diastolic and capnography values were recorded. To study the efficacy of the drugs for emergency surgeries, a technique mimicking rapid sequence induction was followed in these patients.

All patients were administered injection glycopyrrolate 0.2 mg and injection fentanyl 1.5 µg/kg five minutes prior to induction. Preoxygenation with 100% oxygen was carried out for 3 minutes. Anaesthesia was induced with injection thiopentone sodium 5 mg/kg over 20 seconds till there was loss of eyelash reflex. The IV line was flushed with running IV fluid. Cricoid pressure was applied as the patients became unconscious followed by the rapid administration of the study drug. Groups S received injection succinylcholine 1.5 mg/kg body weight and group R received rocuronium bromide 0.8 mg/kg body weight. In both groups of patients, atraumatic laryngoscopy and oral endotracheal intubation was commenced at 60 seconds after the study drug was given with an appropriate sized cuffed endotracheal tube and intubating conditions were graded using the scale adopted by Cooper R et al (1992).[(2)] The anaesthetist who performed laryngoscopy and intubation was blinded by covering the patient with a drape sheet while another anaesthetist loaded the muscle relaxant and administered it. The time taken for laryngoscopy was kept within 15 seconds.

Table 1: Cooper R et al Scale (1992)

Score	Jaw relaxation	Vocal cords	Response to intubation
0	Poor (impossible)	Closed	Severe coughing bucking
1	Minimal (difficult)	Closing	Mild coughing
2	Moderate (fair)	Moving	Slight diaphragmatic movement
3	Good (easy)	Open	None
Total Score	**Excellent 8-9, Good 6-7, Fair 3-5, Poor 0-2**		

Endotracheal tube placement was confirmed by bilateral air entry and capnography and firmly secured and connected to Bain's circuit. Controlled ventilation was started and anaesthesia was maintained with 33% oxygen, 66% nitrous oxide and sevoflurane. The clinical duration of action of initial bolus doses (from the time of

administration of the study drug to the first respiratory attempt) was noted and subsequently all groups were maintained with a requisite dose of injection vecuronium bromide till the end of the surgery.

Vital parameters were recorded and monitored immediately after intubation at one minutes, 3 and 5 minute intervals. If laryngoscopy and intubation failed at 60 seconds, it was repeated at 90 seconds and intubating conditions were assessed again. Any side effects such as ECG changes, muscle fasciculations or any untoward effects due to histamine release such as skin flushing, erythema, etc were also recorded if they occurred.

At the end of surgery all anaesthetic agents were stopped and 100% oxygen was given. Patients were reversed with injection neostigmine 0.05 mg/kg and injection glycopyrrolate 0.01 mg/kg and were extubated after ascertaining adequacy of reversal of neuromuscular blockade.

RESULTS

The results were analyzed using SPSS software version 16 and Epi info 6th version was used for trend analysis. The mean and standard deviation were calculated and used for calculating the significance of difference. Qualitative data were analyzed using Chi-square test. P> 0.05, p< 0.05, p< 0.001 were considered statistically non significant, significant and highly significant respectively.

The study groups did not differ in age, gender and weight distribution and were comparable with each other (Table 2).

Table 2: Demographic Data

Group	Group S	Group R	P – Value with Significance
Mean Age (Years)	37.92±11.60 (SD)	39.88±10.94 (SD)	0.840 (NS)
Mean Weight (Kg)	50.12±6.043 (SD)	49.64±7.27 (SD)	0.803 (NS)
Gender Ratio (M/F)	16/9	17/8	-

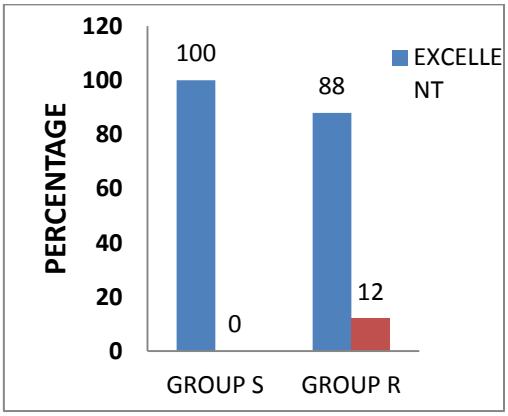
SD – Standard Deviation, NS – Non Significant

In Group S where patients received succinylcholine 1.5 mg/kg body weight, all the 25 patients (100%) had excellent intubating conditions. In Group R where patients received rocuronium bromide 0.8 mg/kg body weight, 22 patients (88%) out of the total 25 showed excellent intubating conditions while 3 patients (12%) out of total 25 showed good intubating conditions. None of the patients in both groups showed fair or poor intubating conditions and there were no cases of failed intubations at 60 seconds. Thus the intubating conditions where statistically non significant (P=0.07) and comparable (Table 3) and (Figure 1).

Table 3: Comparison of the Overall Intubating Condtions.

Intubating conditions and scores	Group S		Group R		Chi square value	P value & significance
	No	%	No	%		
Excellent (8-9)	25	100	22	88	3.19	P = 0.07 Non significant
Good (6-7)	0	0	3	12		
Fair (3-5)	0	0	0	0		
Poor (0-2)	0	0	0	0		
Total	25	100	25	100		

Figure 1: Comparison of Overall Intubating Conditions



As far as the jaw relaxation was concerned, 25 patients (100%) in group S and 23 patients (92%) in group R had good relaxation and were statistically non significant (P=0.148) (Table 4).

Table 4: Comparison of Jaw Relaxation During Intubation.

State	Group S		Group R		Chi-square Value	P-Value with Significance
	No	%	No	%		
Good	25	100	23	92	2.08	P = 0.148 Non significant
Moderate	0	0	2	8		
Poor	0	0	0	0		
Minimal	0	0	0	0		
Total	25	100	25	100		

The vocal cords were open in both group S and group R (100% and 96%) and was statistically non significant (P=0.312) (Table 5).

Table 5: Comparison of Vocal Cords At Intubation.

State	Group S		Group R		Chi-square value	P-Value with significance
	No	%	No	%		
Open	25	100	24	96	1.020	P = 0.312 Non significant
Moving	0	0	1	4		
Closing	0	0	0	0		
Closed	0	0	0	0		
Total	25	100	25	100		

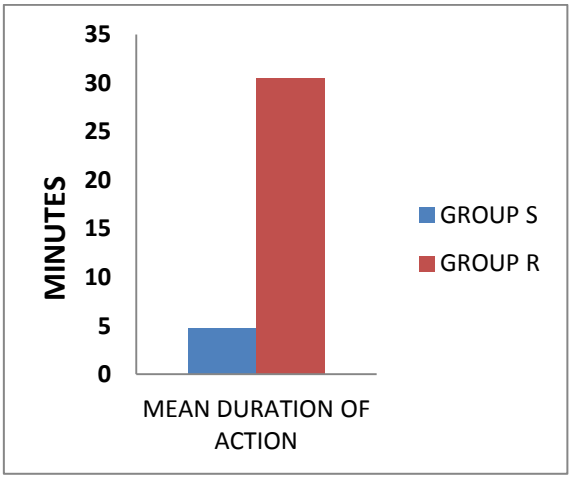
There was no statistically significant response to intubation, in the form of diaphragmatic movements in both the groups (P=0.148) (TABLE 6).

Table 6: Comparison Of Response To Intubation

State	Group S		Group R		Chi-Square value	P-Value with significance
	No	%	No	%		
None	25	100	23	92	2.083	P = 0.148 Non significant
Slight diaphragmatic movement	0	0	2	8		
Mild coughing	0	0	0	0		
Severe coughing/ bucking	0	0	0	0		
Total	25	100	25	100		

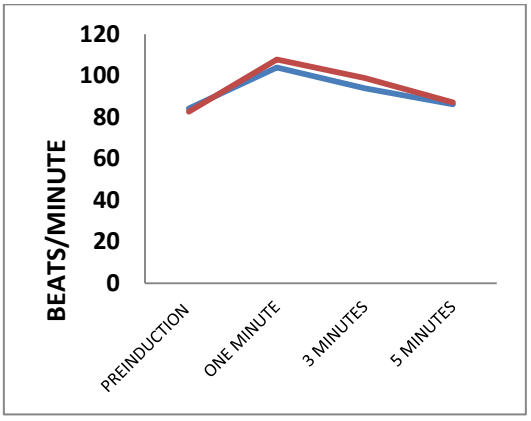
In group S, the minimum duration of action was 3.75 minutes and the maximum duration was 7.25 minutes with a mean duration of 4.74±1.12 minutes. In group R, the minimum duration of action was 25.8 minutes and the maximum duration was 37.90 minutes with a mean duration of 30.50±3.24 minutes (Figure 2).

Figure 2: Comparison of Duration of Action



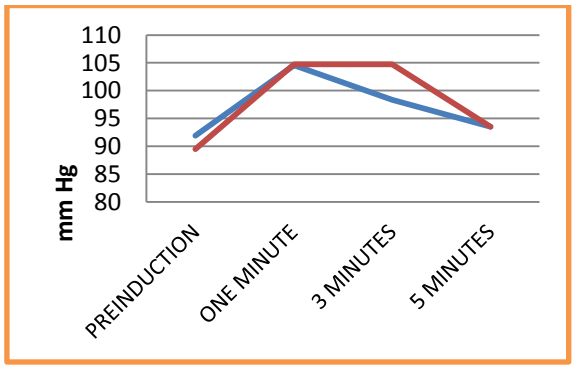
There was significant increase in mean heart rate in group R at one minute after intubation (P=0.042) which returned to pre-induction baseline values at the end of 5 minutes post intubation and was statistically non significant (P=.0572) (FIGURE 3).

Figure 3: Comparison of Mean Heart Rate Variation



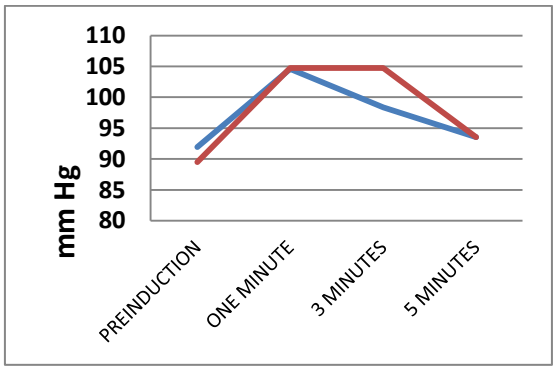
The rise in mean systolic blood pressure was more in group S compared to group R at 3 minutes after intubation (P=0.040) which returned to baseline values by the end of 5 minutes after intubation and was statistically non significant (P=0.166) (Figure 4).

Figure 4: Comparison of Mean Systolic Blood Pressure Variation



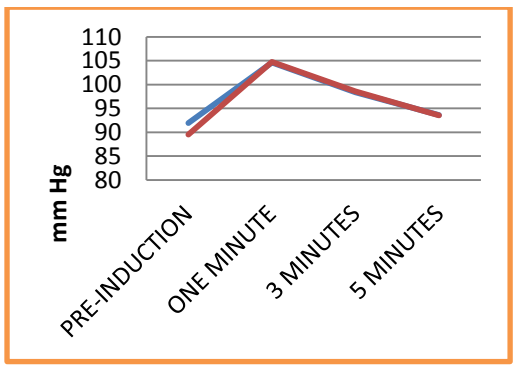
There was no significant increase in mean diastolic blood pressure in both groups post intubation (P=0.310) (Figure 5).

Figure 5: Comparison of Mean Diastolic Blood Pressure Variation



The mean arterial pressures did not rise significantly in both groups at one minute after intubation (P=0.884) but returned to baseline values at the end of 5 minutes post intubation (P=0.957) (Figure 6).

Figure 6: Comparison of Mean Arterial Pressure Variation



DISCUSSION

The rationale in a rapid sequence induction of anaesthesia was to create an environment where the trachea can be intubated quickly with little or no difficulty especially when there was a greater than the usual risk of regurgitation and aspiration of gastric contents. The clinical conditions at the time of intubation therefore play a very important role in this. In the present study we compared rocuronium bromide with succinylcholine in a quest to analyze whether it was sufficiently efficacious to obtain clinically acceptable intubating conditions at 60 seconds and so replace succinylcholine which was a time tested and reliable muscle relaxant of choice for rapid endotracheal intubation.

Rocuronium has been used in doses of atleast two to three times of the ED95 to obtain clinically acceptable intubating conditions comparable with succinylcholine at 60 seconds. The ED95 of rocuronium bromide was 0.3 mg/kg body weight. [3,4] Magorian T et al (1993) [5] recommended that larger doses of rocuronium bromide (0.9-1.2 mg/kg) may be necessary to obtain optimal intubating conditions similar to succinylcholine. But, increasing the dose of rocuronium led to a longer duration of action. Rocuronium 0.9 mg/kg had a clinical duration of 53±21 minutes and rocuronium 1.2 mg/kg had a clinical duration of 73±32 minutes. Hence we decided to use rocuronium at a dose of 0.8 mg/kg body weight in comparison with succinylcholine 1.5 mg/kg body weight in order to keep the duration of action to the minimum.

The criteria put forth by Cooper R et al (1992) were the most commonly adopted in most of the researches as it had a quantifiable numerical scoring system unlike others. Hence we decided to use the same for assessing the quality of intubating conditions.

In our study Succinylcholine 1.5 mg/kg body weight produced excellent intubating conditions in 100% of the patients. The results were comparable to those studies conducted by Shukla A et al (2004) [6], Misra MN et al (2005) [7], Bhati K and Parmar V (2008) [8], Gupta S and Kirbahar R

(2010) [9], Parikh K et al (2014) [10] and Khurshid H et al (2015) [11].

Rocuronium bromide 0.8 mg/kg produced excellent intubating conditions in 88% of the patients and good conditions in 12% of the patients. This was comparable to the studies conducted by Magorian T et al (1993) [5], Dwivedi S and Dwivedi R (2015) [12], Penchalaiah CH et al (2015) [13], Heggeri VM et al (2015) [14] and Khurshid H et al (2015) [11]. Also at this dose we did not see moving vocal cords except in one patient. Slight diaphragmatic movements were also not observed except in 2 patients. These responses will be undesirable if the patient was considered to be at risk of pulmonary aspiration of gastric contents though no such complication arose in our study.

The clinical duration of action in the present study was taken as the time between the administration of the neuromuscular blocking drug and the first attempt at respiration.

With Succinylcholine 1.5 mg/kg body weight the clinical duration of action in this study was found to be with a mean duration of 4.74±1.12 minutes. The minimum duration was 3.75 minutes and the maximum was 7.25 minutes. The results were comparable with the studies by Shukla A et al (2004) [6], Parikh K et al (2014) [10] and Khurshid H et al (2015) [11].

Rocuronium at a dose of 0.8 mg/kg body weight had a minimum duration of action 25.8 minutes and the maximum duration of action was 37.90 minutes. The mean duration of action was 30.50±3.24 minutes. This was comparable to the study done by Khurshid H et al (2015) [11]. Also the decreased duration of action of rocuronium was preferable for surgical procedures of short duration.

In our study, the rise in heart rate by 23.47% and 30.30% from baseline was seen one minute after intubation in group S and group R respectively. This gradually declined to 11.60% and 19.55% respectively at 3 minutes and further declined to 2.38% and 5.32% at the end of 5 minutes thereby returning to pre-induction baseline values and became statistically non significant.

The increase in mean systolic blood pressures at one minute post intubation was 16.66% and 16.82% from baseline values in group S and group R respectively. This decreased to 3.5% and 8.68% at the end of 3 minutes and further decreased to 2.49% and 3.97% respectively at the end of 5 minutes and became statistically non significant. Furthermore the mean diastolic blood pressures increased by 15.12% and 16.7% from the baseline values in group S and group R at the end of one minute and declined to 8.91% and 11% at the end of 3 minutes. This further declined to 3.10% and 4.84% respectively at the end of 5 minutes and became statistically non significant.

The mean arterial pressure increased by 13.75% and 17.04% in group S and group R respectively at the end of one minute and declined to 7% and 17.03% at the end of 3 minutes. This further decreased to 1.8% and 4.49% and returned to pre-induction values at the end of 5 minutes and became statistically non significant.

These changes concurred with the studies conducted by Misra MN et al (2005) [7], Verma et al (2006) [15], Bhati K and Parmar V (2008) [8], Dwivedi S and Dwivedi R (2015) [12], Penchalaiah CH et al (2015) [13], Kotambkar V and Tuljapure S (2015) [16] and Khurshid H et al (2015) [11]. These hemodynamic changes could be attributed to the stress response of intubation. Thus rocuronium bromide was found to be a relatively thermodynamically stable drug.

In our study, no destauration or any adverse changes in ECG occurred. Other untoward side effects such as bradycardia, tachycardia, hypotension, hypertension, bronchospasm, cutaneous fl ushing, erythema, urticaria, or rashes were also not observed. Only the predicted muscle fasciculations after the administration of succinylcholine was noticed.

In our study we used a thiopentone at the usual dosage and a relatively small dose of fentanyl just like the study done by McCourt KC et al (1998) [17]. The intubating conditions could have been better if propofol or alfentanil or even a higher dose of fentanyl had been used as a part of the induction technique. This was proved by Crul JF

et al (1995) [18] who reported excellent intubating conditions within 45 seconds with rocuronium 0.9 mg/kg and concomitant use of propofol and alfentanil but then it might have interfered with the intubating conditions.

CONCLUSION

Rocuronium bromide at a dose of 0.8 mg/kg was a hemodynamically stable, non depolarizing muscle relaxant, which produced early satisfactory intubating conditions at 60 seconds comparable with succinycholine. It may be considered as a suitable alternative to succinylcholine in rapid sequence induction of anaesthesia in emergency situations when succinylcholine is hazardous or containdicated. It also had a shorter duration of action compared to the usual high dose rocuronium (0.9-1.2 mg/kg) given in rapid sequence induction of anaesthesia.

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