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Rocuronium and Succinylcholine: A Comparison of Intubating Conditions in a Rapid Sequence Induction with Thiopentone

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Abstract

Background and Aim: Succinylcholine is the gold standard for rapid sequence induction of anesthesia. An alternative neuromuscular blocker (NMB) with comparable quick onset and short duration is desirable in situations where its use is contraindicated. Rocuronium offers promise especially after the introduction of sugammadex. There is still some concern regarding the quality of intubating conditions provided at 60 seconds. *Methods and Materials:* Forty patients undergoing elective surgery under general anesthesia were randomly divided into two groups. For intubation Group R received i.v. rocuronium bromide 0.6 mg/kg and Group S received succinylcholine 1 mg/kg. Rapid sequence induction was performed with injection thiopentone 5 mg/kg followed immediately by the NMB according to the assigned group. Intubation was performed one minute after the NMB and intubating conditions assessed and graded on a four-point scale: Excellent = jaw relaxed, vocal cords apart and immobile, no diaphragmatic movement; Good = jaw relaxed, vocal cords apart and immobile, some diaphragmatic movement; Poor = jaw relaxed, vocal cords moving, bucking; Inadequate = jaw not relaxed, vocal cords adducted, uncontrolled cough/bucking. Good and excellent conditions were together taken as clinically acceptable. *Results:* All the 20 intubations performed in group S and only 11 in Group R were rated as excellent one minute after the injection of muscle relaxant ($p < 0.001$). They were rated clinically acceptable in 18 patients in Group R compared to 20 patients in Group S ($p > 0.05$). *Conclusions:* Rocuronium provides clinically acceptable intubating conditions similiar to succinylcholine at 60 seconds and can be considered a safe alternative for rapid tracheal intubation in select situations where succinylcholine is contraindicated.

Keywords: Rocuronium; Succinylcholine; Thiopentone; Intubating conditions.

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Introduction

Modern anesthesia practice relies heavily on general anesthesia. Though a lot of development has been made in the field of supraglottic devices, tracheal intubation still remains the ideal choice to provide airway protection in patients at risk of gastric aspiration.[1] The technique most frequently employed is the rapid sequence induction, designed to minimize the interval between suppression of protective reflexes and accomplishment of intubation. The ideal neuromuscular blocker (NMB) should have a fast onset and brief duration of action.[2]

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Succinylcholine is the gold standard in muscle relaxants and consistently provides muscle relaxation within 60 seconds.[3] The duration of action is also short (4–9 minutes). Its use is, however, contraindicated in situations like myotonia, plasma cholinesterase deficiency, sepsis, head injury, perforated eye or susceptibility to malignant hyperthermia.[4]

Thus, a non-depolarising NMB with a short onset and duration; minus the disadvantages is desirable. The quest for 'non-depolarising succinylcholine' has led to the development of various NMBs including the short-acting mivacurium and rapacuronium. None of these has however stood the test of time. Rocuronium offers the fastest onset of action of all the clinically available drugs.[5] Intermediate duration of action however reduces the margin of safety and precludes its use in anticipated difficult intubations. The recent introduction of the specific reversal agent sugammadex, however, has made this choice lucrative.[3] Another concern is the quality of intubating conditions within one minute of injection. Incomplete relaxation can lead to unwanted movements and complications like coughing, bucking and laryngospasm. The choice of induction agent also makes a difference, and use of propofol is associated with better relaxation of the vocal cords.[6]

Thiopentone is another popular induction agent for emergency procedures because it offers advantage in hemodynamically unstable patients, but it provides considerably less relaxation than propofol. The main aim of this study was to assess the number of patients with excellent intubating conditions one minute after injection of low dose rocuronium (0.6 mg) given as a part of the rapid sequence induction, with thiopentone sodium as the induction agent and compare these to succinylcholine. The secondary aim was to assess clinically acceptable intubating conditions, onset and duration of rocuronium and succinylcholine, any difference in hemodynamic effects during induction and intubation, and complications of the study drugs.

Materials and Methods

After obtaining the ethics committee approval, 40 ASA physical status I or II patients of both sexes, aged 18–65 years and scheduled for elective surgery under general anesthesia were included in the study. Patients with anticipated difficult airway, pregnancy, obesity or malnourishment, presence of hepatorenal disease, any evidence of neuromuscular dysfunction or on medications known to interfere with neuromuscular function were excluded.

A careful preanesthetic assessment including routine laboratory investigations was performed a day before and informed written consent obtained. All patients were instructed to keep fasting for six hours before surgery.

The patients were randomly divided into two groups of 20 each by the chit in box method. An anesthesia assistant not involved in data collection would draw a chit and prepare drugs accordingly. Each chit was used only once. For intubation the Group S received succinylcholine 1 mg/kg i.v. and group R received i.v. rocuronium bromide 0.6 mg/kg.

On arrival in the operation theater, an intravenous (i.v.) cannula was inserted in a suitable vein on the forearm and 500 mL normal saline or Ringer lactate started. Routine monitoring including electrocardiogram (ECG), noninvasive blood pressure (BP) and arterial oxygen saturation (SpO_2) was established. All patients were premedicated with injection glycopyrollate (0.004 mg/kg), tramadol (1 mg/kg) and midazolam (0.02–0.05 mg/kg) given i.v. approximately 10 minutes before induction of anesthesia. Baseline Heart rate (HR) and mean arterial blood pressure (BP) were recorded just before induction; then before intubation, one minute after intubation and five minutes after intubation.

After preoxygenation for three minutes with 100% oxygen via face mask, rapid sequence induction was performed with injection thiopentone 5 mg/kg followed by 0.6 mg/kg rocuronium bromide or 1 mg/kg succinylcholine. Injection thiopentone was given over 20 seconds and infusion line flushed for 5–10 seconds to avoid incompatibility of the drugs. The muscle relaxant was given according to the assigned group. Ventilation with a mixture of oxygen and halothane was continued for one minute following which intubation was performed with appropriate sized cuffed endotracheal tube. The investigator performing tracheal intubation and assessing intubating conditions was summoned at the time of intubation and efforts were made to disguise the fasciculations produced by succinylcholine in order to remove observer bias. All intubations were performed by the same investigator and graded on a four point scale: Excellent = jaw relaxed, vocal cords apart and immobile, no diaphragmatic movement; Good = jaw relaxed, vocal cords apart and immobile, some diaphragmatic movement; Poor = jaw relaxed,

vocal cords moving, bucking; Inadequate = jaw not relaxed, vocal cords adducted, uncontrolled cough/bucking. Good and excellent conditions were together taken as clinically acceptable. After intubation the cuff was inflated and tube placement confirmed. Controlled ventilation was started and halothane in a mixture of 50% N_2O and 50% O_2 was given for maintainence of anesthesia. Heart rate (HR), ECG, NIBP and SpO_2 were monitored continuously. At the end of surgery, all anesthetics were discontinued and patients breathed 100% oxygen. Respiratory efforts were allowed to return following which reversal of neuromuscular blockade was provided by neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. Extubation was performed as per the clinician's judgement when adequate and regular spontaneous breathing was established and patients were able to open eyes to commands. Patients were oxygenated for five minutes and shifted to the recovery room for close observation.

For neuromuscular monitoring, the ulnar nerve was stimulated at the wrist with a peripheral nerve stimulator (Inmed Equipment, Vadodra) using a train-of-four (TOF) sequence and the resultant contraction of adductor pollicis muscle was observed visuallly. Baseline response was observed after the administration of thiopentone, but before the administration of muscle relaxant. Time from injection of muscle relaxant to complete ablation of first twitch of TOF (T_1) was taken as the onset of action of muscle relaxant. The time from injection to appearance of T_1 was taken as the clinical duration of action.

Statistical Analysis

After completion of the study, the data was compiled, tabulated and analyzed. Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) 17.0 software. Data is expressed as means and standard deviation (Mean ± SD) or numbers and frequency as appropriate. Chi-square test was used to compare categorical and student's '*t*' test for parametric data. *p* value of less than 0.05 was considered significant and less than 0.001 as highly significant. Sample size was calculated for the primary outcome based on previous studies. 18 subjects were needed to prove any difference with 95% confidence interval and power of 80%. The number was rounded off to include 20 patients.

Results

In the present study 40 patients were studied to assess the intubating conditions provided by low dose rocuronium (0.6 mg/kg) after induction with thiopentone and to establish its comparison with succinylcholine. The two groups were comparable with respect to the demographic data (age, sex and weight) (Table 1). The primary outcome was assessment of intubating conditions one minute after the injection of muscle relaxant. All the 20 intubations performed in Group S and only 11 in Group R were rated as excellent ($p < 0.001$) (Table 2). They were rated good in 7 patients, poor and inadequate in 1 patient each in Group R. Thus the clinically acceptable conditions were observed in 18 patients in Group R compared to 20 patients in Group S ($p > 0.05$). A significant increase in heart rate (HR) after induction was observed in the Group R ($p < 0.001$) (Figure 1). Both the groups had significant tachycardia one minute after intubation compared to baseline values ($p < 0.001$), however within five minutes, this returned to pre-induction heart rate ($p > 0.05$). The mean rise in HR after intubation was comparable between the groups ($p > 0.05$). A significant rise in mean arterial pressure (BP) was observed after intubation in both the groups ($p > 0.05$), however the rise in BP was comparable in the groups ($p > 0.05$) (Figure 2).

The onset of action of rocuronium was 97.20 ± 31.36 seconds compared to 58.20 ± 11.86 seconds with succinylcholine ($p < 0.001$) (Table 3). The clinical duration of action of rocuronium was 25.80 ± 5.05 minutes compared to 4.74 ± 1.55 minutes with succinylcholine ($p < 0.001$). No complications related to the use of the NMBs were observed.

Table 1: Demographic Data

Parameters	Group R (n=20) Mean ± SD	Group S (n=20) Mean ± SD	t / x^2	*p* value
Age (years)†	41.05 ± 15.63	36.00 ± 11.91	1.149	0.257
Weight (kg)†	61.40 ± 10.30	63.00 ± 8.49	0.657	0.519
Sex (Male/Female)*	6/14	8/12	0.440	0.507

† - *p* calculated by student's *t* test, *- *p* calculated by χ^2 test, $p > 0.05$ not significant, $p < 0.05$- significant, $p < 0.001$ highly significant.

Table 2: Intubating Conditions Observed in Study Group Patients

Intubating Conditions	Group R (n=20)		Group S (n=20)		x^2	*p* value
	No.	%	No.	%		
Excellent	11	55%	20	100%		
Good	7	35%	0	–	**11.61**	**< 0.001**
Poor	1	5%	0	–		
Inadequate	1	5%	0	–		

p > 0.05 non-significant, *p* < 0.05- significant, *p* <0.001 highly significant.

Table 3: Onset and Duration of Action of Intubating Dose of Muscle Relaxants in the Study Group Patients

Variables	Group R (n=20) Mean ± SD	Group S (n=20) Mean ± SD	t value	*p* value
Onset of Action (seconds)	97.20 ± 31.36	58.20 ± 11.86	5.202	<0.001
Duration of Action (minutes)	25.80 ± 5.05	4.74 ± 1.55	17.829	<0.001

p > 0.05 non-significant, *p* < 0.05- significant, *p* < 0.001 highly significant

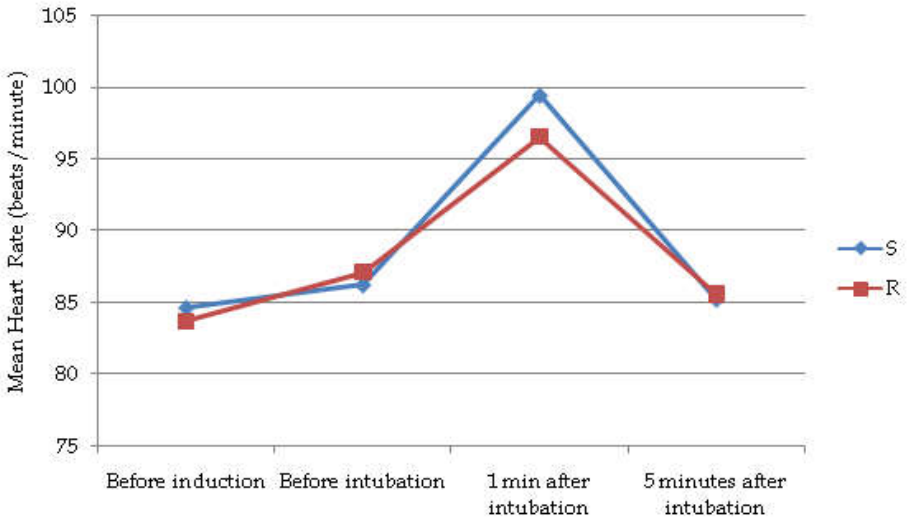

Fig. 1: Heart rate in relation to induction and intubation.

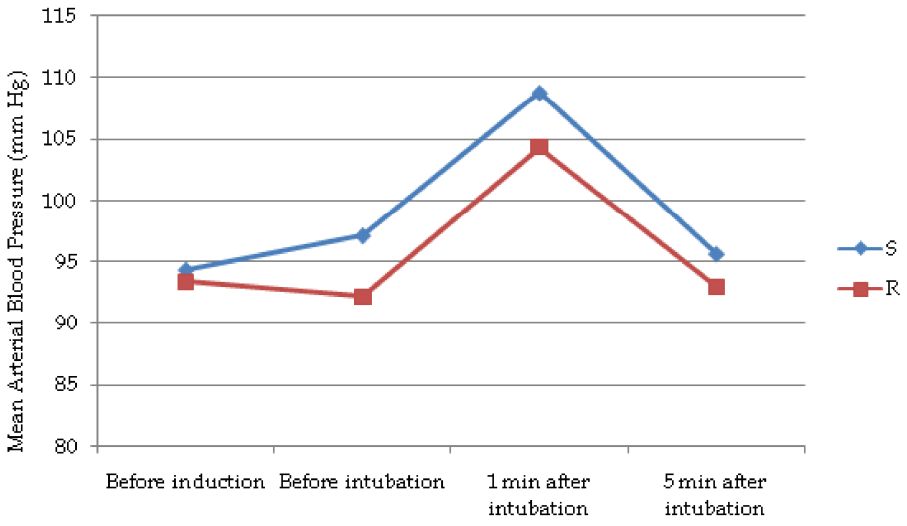

Fig. 2: Mean arterial pressure in relation to induction and intubation.

Discussion

Intubating conditions: The present study showed that low dose rocuronium (0.6 mg/kg) when used along with thiopentone sodium in the setting of rapid sequence induction, results in significantly less number of intubations graded as excellent (55%), compared to succinylcholine (100%). However, if diaphragmatic movement was ignored, the intubating conditions grouped together as clinically acceptable were comparable between the groups.

Cooper *et al.* observed excellent conditions in 95% patients receiving succinylcholine and 65% receiving rocuronium.[5] Those graded clinically acceptable were comparable in the two groups which is similar to our study. Misra *et al.* reported the incidence of excellent intubating conditions as 90% with succinylcholine and 70% with administration of rocuronium and thiopentone.[7] This was higher than our observation and can be explained by a difference in the definitions. They reported 56.7% patients with mild cough, citing delayed effect of rocuronium on diaphragm. In our study any cough or diaphragmatic movement was graded as good (clinically acceptable). Puhringer *et al.* and Huizinga *et al.* indicated that rocuronium and succinylcholine produce indistinguishable intubating conditions one minute after administration.[8,9] This could be attributed to the use of opioid premedication or propofol induction. Although these agents do not affect the neuromuscular blocking properties of rocuronium, they may promote the development of good intubating condtions on their own. Sparr *et al.* on the contrary reported excellent conditions in 80% and 40% patients intubated 60 seconds after succinylcholine and rocuronium respectively.[10]

Hemodynamic Parameters: Preoperative HR and BP in each group were taken as control. Significant increase in heart rate was observed post induction in the rocuronium group. Similiar observations were recorded by Misra *et al.* and Booth *et al.*[7,11] The rise in heart rate and blood pressure after intubation in all the patients is explained by the stress response to laryngoscopy and intubation. This response was comparable in the two groups and had completely abated five minutes after laryngoscopy, thus affirming that the two muscle relaxants do not cause any significant hemodynamic perturbations.

Onset of action: The observed onset of action was comparable to Naguib *et al.* who reported 97.9 ± 29 seconds and 55.1 ± 11.4 seconds respectively with rocuronium and succinylcholine.[12] Other authors also observed similar times.[5,13-15] However, considerably longer onset times were reported by some authors.[8,9,16]

Duration of action: Rocuronium has an intermediate duration of action, as was affirmed in our study. The mean duration of action with the 0.6 mg/kg rocuronium was 25.80 ± 5.05 minutes and 4.74 ± 1.55 minutes which was similiar to that observed by Huizinga *et al.* (24 ± 4, 5 ± 1) and Naguib *et al.* (23.7 ± 5.1, 4.2 ± 1.4).[9,12] Magorian *et al.*, however reported considerably longer duration of 37 ± 15 and 9 ± 2 minutes with the same doses of rocuronium and succinylcholine respectively. The observed differences may be due to the difference in technique and the definition of the duration of action.[15]

Conclusion

From the present study, we conclude that 0.6 mg/kg rocuronium after induction with thiopentone provides an incidence of clinically acceptable intubating conditions that is comparable to succinylcholine at 60 seconds. Succinylcholine, however, ramains the gold standard as it offers unparalled relaxation. Rocuronium, therefore, should be considered as a safe alternative for rapid tracheal intubation in select situations where succinylcholine is contraindicated.

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