ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

A comparative study of intubating conditions using succinylcholine and two doses of rocuronium

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Manuscript Info

Manuscript History:

Received: 18 March 2015
Final Accepted: 19 April 2015
Published Online: May 2015

Key words:

Intubating conditions, Rocuronium, Succinylcholine.

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Abstract

To secure and maintain a patent airway is the prime role of anaesthesiologists. Succinylcholine, because of its ultra-rapid onset and ultra-short duration of action has been the main neuromuscular blocking agent and is considered the gold standard for tracheal intubation. Certain undesired adverse effects of succinylcholine have led to the search for an ideal substitute for this drug. Rocuronium bromide, a relatively newer non-depolarizing muscle relaxant, owing to its rapid onset of action can be preferable to succinylcholine in order to avoid its adverse effects. The aim was to compare the onset time, duration of action, intubating conditions and haemodyanamic effects of rocuronium bromide with that of succinylcholine. A total of 90 adult patients of either sex aged between 20 to 60 years were selected randomly and divided into three groups. Group S received succinylcholine 1.5mg/kg, group R1 and R2 received rocuronium 0.6mg/kg and 0.8mg/kg respectively before intubation. The neuromuscular block was assessed by using train of four stimulation at adductor pollicis muscle every 20 seconds.We observed that both the onset time and duration of action was significantly shorter for succinylcholine group in comparison to rocuronium groups, and increasing the dose of rocuronium shortened the onset of muscle relaxation. The intubating conditions were clinically acceptable (excellent + good) in 100% of patients (excellent in 93%) of group S, 93% of patients (excellent in 53%) of group R_1, and 100% of patients (excellent in 83%) of group R_2.there was no significant change in heart rate and mean arterial pressure from the baseline value after the administration of muscle relaxants in either of the three groups. We conclude that rocuronium can be used as a safer alternative to succinylcholine for rapid tracheal intubation in conditions where the later is contraindicated or hazardous.

INTRODUCTION

Neuromuscular blocking agents have been an essential part of the anaesthetists' armamentarium for more than fifty years1. The introduction of muscle relaxants, more appropriately called neuromuscular blocking agents, was an important milestone in the history of anaesthesia2. The use of neuromuscular blocking agents has not only revolutionised the practice of anaesthesia, but has also allowed the modern era of surgery to flourish3. Introduction of succinylcholine changed the anaesthetic practice drastically. Further, this drug has been particularly found to be helpful in rapid tracheal intubation4. Therefore, right since its introduction, succinylcholine has been the main neuromuscular blocking agent for endotracheal intubation with special application in rapid sequence induction and difficult intubation5. Among the depolarizing muscle relaxants, only succinylcholine is still being used clinically and continues to retain its popularity, being the only neuromuscular blocking drug with ultrarapid onset and

ultrashort duration of action6. For these qualities, this drug still occupies the first position in providing excellent conditions for endotracheal intubation. Adverse effects of succinylcholine include fasciculations7, hyperkalemia8,9, post-operative muscle pains10, rise in intragastric, intracranial and intraocular pressure11. These adverse effects are undesired in a specific group of patients and for this reason there has been a continuous and concerted effort to acquire a safer neuromuscular blocking agent to replace succinylcholine12,13. A non-depolarizing muscle relaxant with relatively quick onset and short duration of action would be an ideal substitute to succinylcholine12,13. In this regard, rocuronium bromide, a relatively newer non-depolarizing muscle relaxant with intermediate duration of action can be a good choice. Rocuronium became available for clinical use in 1995 and it is the first non-depolarizing neuromuscular blocking drug considered to be an acceptable parallel drug for facilitating rapid intubation of trachea14. Rocuronium has the most rapid onset of action among the currently available non-depolarizing neuromuscular blocking drugs15. Unlike succinylcholine, its use is not associated with muscle fasciculations, hyperkalemia, post-operative myalgias, etc. It exhibits a low potential for systemic histamine release16 and does not produce any significant change in cardiovascular parameters17. It also does not show any significant cumulative effect in most of the patients18. Thus, rocuronium can be an ideal agent for rapid sequence induction of anaesthesia and may be preferable to succinylcholine in many cases, particularly in cardiac compromised patients19. This study was conducted to compare the intubating conditions, onset and duration of clinical relaxation and cardiovascular effects after administration of rocuronium and succinylcholine in adult patients undergoing elective surgery.

1. METHOD

This clinical study was conducted in the Department of Anaesthesiology in Government Medical College, Srinagar during the period of 2010-2011. After getting approval from the institutional ethical committee, a total of 90 adult patients of either sex, aged between 20 to 60 years, belonging to either ASA class I or II, posted for elective surgery were included in this study. In order to avoid any interference with the results, following patients were excluded from this study: Patients with potential airway problems and suspected difficult intubations, patients suffering from any neuromuscular disease, patients receiving any medication known to interact with neuromuscular blocking agents, patients with clinical or biochemical evidence of renal, hepatic, cardiovascular or respiratory dysfunction.

Patients were randomly assigned to any one of the following three groups with 30 patients in each group. Group S patients receiving intravenous Succinylcholine (1.5 mg/kg), Group R1 patients receiving intravenous Rocoronium (0.6 mg/kg) and Group R2 patients receiving intravenous Rocuronium (0.8 mg/kg). All patients entering this study were subjected to a detailed pre-anaesthetic evaluation and the presence of significant systemic disease and difficult airways were ruled out. Informed consent was taken and procedure of the study was explained to them. Each patient was taken up without having received any premedication. In the operation theatre, an intra-venous line was secured with appropriate size intravenous cannula. Monitors included non-invasive blood pressure, electrocardiogram, pulse oximeter and neuromuscular monitor– TOF. The ulnar nerve was used for neuromuscular stimulation. Surface electrodes were applied over the volar aspect of forearm, along the course of ulnar nerve after adequate preparation of the area. The negative electrode was placed about 1 cm proximal to the proximal wrist crease. The other electrode was placed 3-4 cm proximal to the first one. A supramaximal current of 60 mA was selected for stimulation and evoked response was recorded every 20 seconds. Onset time was recorded on complete ablation of the first twitch of train of four.

Baseline heart rate, non-invasive blood pressure, arterial oxygen saturation and electrocardiogram was recorded for each patient. All patients were pre-oxygenated with 100% oxygen for 3 minutes. The patients were then induced with sodium thiopentone 5mg/kg intravenous injection. Then they received at random a bolus dose of either succinylcholine 1.5 mg/kg I.V., rocuronium 0.6 mg/kg I.V., or rocuronium 0.8 mg/kg I.V. Paients were then intubated using appropriate size of endotracheal tube after assessing the onset time with neuromuscular monitoring. Intubating conditions were assessed according to the four point scale of Cooper et al[20] as under:

TABLE 1- Scoring of intubating conditions

SCORE	JAW RELAXATION	VOCAL CORD POSITION	RESPONSE TO INTUBATION
0	Poor	Closed	Severe coughing or bucking
1	Minimal	Closing	Mild coughing

2	Moderate	Moving	Slight diaphgramatic movement
3	Good	Open	None

The scores were added up and further grouped as: 8–9 = Excellent, 6–7 = Good, 3–5 = Fair and 0–2 = Poor. Good and excellent scores were taken as clinically acceptable.

After intubation the cuff of the endotracheal tube was inflated and the tube was connected to Bain's circuit and controlled ventilation was started with nitrous oxide, oxygen and isoflurane. At the end of surgery, neuromuscular block was reversed with (injection neostigmine 0.05 mg/kg plus injection atropine 0.02 mg/kg) I.V. A thorough oropharyngeal suctioning was done, and then the patients were extubated after they were fully awake and when train of four ratio returned to 90% of the control.

Following observations were recorded. Intubating conditions: assessment of three facets of intubation (jaw relaxation, vocal cord position, and reaction to intubation) was done. This provided us with overall grading of intubating conditions. Onset of action: response of adductor pollicis muscle to percutaneous ulnar nerve stimulation at the wrist was recorded to determine the onset and duration of action of neuromuscular blocking agents. Haemodyanamic parameters: cardiovascular data (non-invasive blood pressure, heart rate and electrocardiogram) was recorded before induction (baseline), at the time of intubation, and then after every minute for 10 minutes. Oxygen saturation: arterial oxygen saturation was monitored at the same intervals as haemodyanamic parameters. Muscle fasciculations: occurrence of fasciculations was also recorded. Other side effects: any untoward effects like skin flush, erythema, itching were also recorded.

The results were compiled and analyzed statistically by using one way ANOVA test, chi square test and equal variance test.

2. RESULTS

The three study groups did not differ with respect to age, weight or gender distribution.

TABLE 2- Demographic data

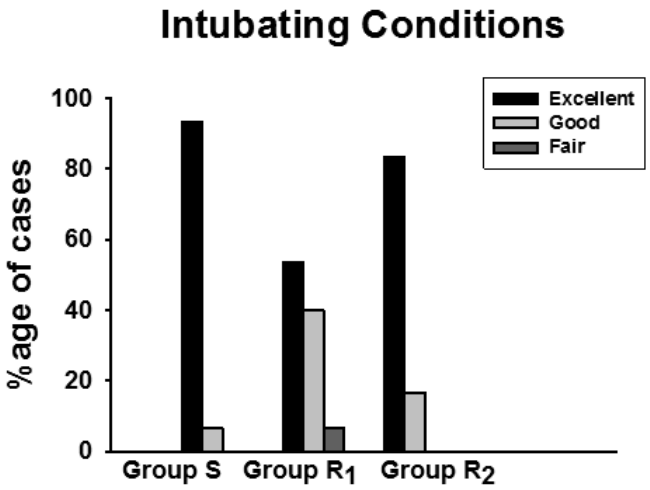
GROUP	Group S	Group R_1	Group R_2
Age (years)	37.97 ± 9.76	36.97 ± 10.46	39.00 ± 10.01
Weight (Kg)	58.10 ± 7.53	56.76 ± 7.80	56.40 ± 6.97
Gender (M/F)	17/13	14/16	16/14

The intubating conditions were assessed using the four point scale of Cooper et al.[10] In group S excellent intubating conditions were found in 28(93.33%) patients out of 30 patients and good intubating conditions were found in 2(6.67%) patients. None of the patients were found to have fair or poor intubating conditions. In group R_1, 16(53.33%) out of 30 patients had excellent intubating conditions, 12(40%) patients had good intubating conditions and 2(6.67%) patients had fair intubating conditions. In group R_2, the intubating conditions were found to be excellent in 25(83.33%) patients out of 30 patients and good in 5(16.67%) patients. In this group also none of the patients had fair or poor intubating conditions. Overall, acceptable intubating conditions were found in 100% patients in group S and group R_2, and 93.33% patients in group R_1.

TABLE 3- OVERALL INTUBATING CONDITIONS

INTUBATING CONDITIONS	GROUP S		GROUP R_1		GROUP R_2	
	No	**%**	**No**	**%**	**No**	**%**
EXCELLENT	28	93.33	16	53.33	25	83.33
GOOD	2	6.67	12	40	5	16.67

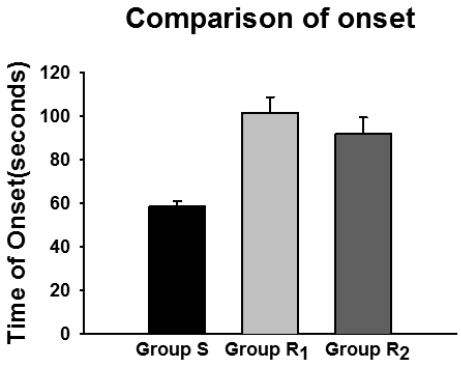
FAIR	-	-	2	6.67	-	-
POOR	-	-	-	-	-	-

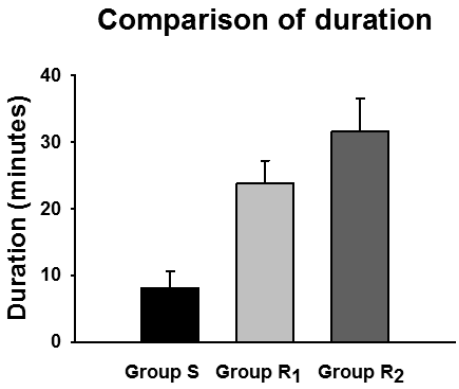


The onset time of complete neuromuscular blockade was measured at the adductor pollicis muscle using train of four stimulation on complete ablation of the first twitch of train of four. The mean onset time was significantly longer for group R_1 (mean 101.73 ± 7.10 seconds) than group R_2 (mean 91.80 ± 7.77 seconds), which was significantly longer than group S (mean 58.50 ± 2.50 seconds) with p values < 0.001. The duration of action was measured at the adductor pollicis muscle using train of four stimulation when the recovery of train of four ratio reached to 25%. The mean duration of action for group S was 8.10 ± 2.52 minutes, for group R_1 mean duration of action was 23.73 ± 3.45 minutes and for group R_2 the mean duration of action was 31.50 ± 5.04 minutes. The difference between the three groups was found to be statistically significant with p value < 0.001.

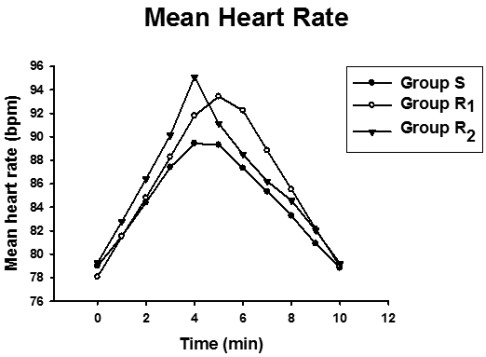
TABLE 4- Time course of action

GROUP	**Group S**	**Group R_1**	**Group R_2**
Onset (sec)	58.50 ± 2.50	101.73 ± 7.10	91.80 ± 7.77
Duration (min)	8.10 ± 2.52	23.73 ± 3.45	31.50 ± 5.04
P value	R_1 Vs S	S Vs R_2	R_1 Vs R_2
	< 0.001	< 0.001	< 0.001

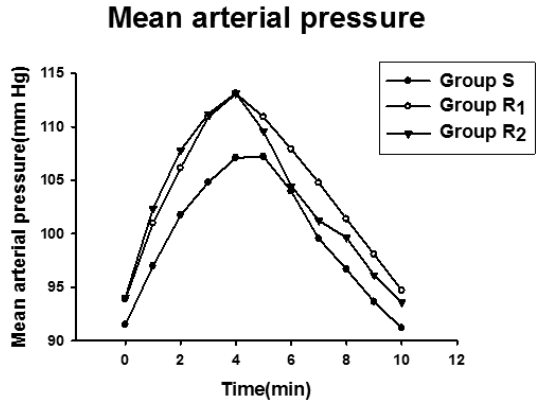




No significant change in heart rate from the baseline value was observed in all the three groups after the administration of the relaxant ($p > 0.05$). There was a rise of heart rate from the baseline values for upto 4 to 5 minutes followed by a decreasing trend and reaching back to baseline values by the end of 10 minutes.



The mean arterial pressure also had the same variability as that of heart rate showing an increase from baseline upto 4 to 5 minutes and then declining back and reaching back to baseline by the end of 10 minutes. The overall variability in heart rate was found to be statistically insignificant with $p > 0.05$.



Patients who received succinylcholine as the neuromuscular blocking agent for induction were shown to have muscle fasciculations after recieving the drug, whereas patients in the other two groups did not show any such effect.

3. DISCUSSION

Succinylcholine is the main muscle relaxant used for providing conditions necessary for easy and atraumatic intubation. However, provision of muscle relaxation for this purpose needs a drug safer than succinylcholine with properties comparable to it and minimum side effect[21]. Many studies including our study using show that rocuronium rapidly produces acceptable intubating conditions, which approach, if not equal to that of succinylcholine[22].

A number of studies have evaluated the equivalence of tracheal intubating conditions when rocuronium and succinylcholine was used at the start of anaesthesia. Weiss et al[23] in their study have shown that rocuronium in a dose of (0.9 mg/kg) provides intubating conditions similar to succinylcholine(1.5 mg/kg). Intubating conditions following (0.7 mg/kg) dose of rocuronium were not as good as following (0.9 mg/kg) dose of rocuronium and succinylcholine(1.5 mg/kg). Bunburaphong et al[22] in their study have found that following different doses of rocuronium (0.3 mg/kg, 0.6 mg/kg, and 0.9 mg/kg) at one minute, clinically acceptable intubating conditions were seen in 50%, 85% and 95% cases respectively. Andrews et al[24] have reported that intubating conditions with rocuronium(1.0 mg/kg) are superior to those with rocuronium(0.6 mg/kg). Thus rocuronium (1.0 mg/kg) and succinylcholine(1.0 mg/kg) show similar incidence of clinically acceptable intubating conditions. Kulkarni et al[25] in their study reported that (0.9 mg/kg) dose of rocuronium provides highest probability of successful rapid tracheal intubation which is comparable to that of succinylcholine(1.5 mg/kg) as compared to (0.6 mg/kg) dose of rocuronium. Clinically acceptable intubating conditions were obtained in 100% of patients receiving succinylcholine (1.5 mg/kg) and rocuronium(0.9 mg/kg), and 92% of the patients receiving rocuronium(0.6 mg/kg). Nilesh Kumar et al[26] have also shown in their study that rocuronium in a dose of (0.9 mg/kg) provides intubating conditions comparable to succinylcholine (1.5 mg/kg). These observations are in conformity with those of our study.

Magorian et al[12] reported an onset time of 50.0 ± 17.0 seconds with succinylcholine (1 mg/kg), 89.0 ± 33.0 seconds and 75.0 ± 28.0 seconds after rocuronium (0.6 mg/kg and 0.9 mg/kg) respectively, thus showing a dose dependent decrease in onset time with rocuronium. Hemmerling et al[27] in their study have shown the onset time with succinylcholine (1.0 mg/kg) as 56 ± 15 seconds, and that with increasing doses of rocuronium (0.4 mg/kg, 0.8 mg/kg and 1.2 mg/kg) as 155 ± 40 seconds, 74 ± 36 seconds and 65 ± 21 seconds respectively. Verma et al[19] and Wierda et al[28] reported considerably longer time of onset. Wierda et al[28] reported an onset time of 172.0 seconds after rocuronium(0.6 mg/kg). Verma et al[19] reported an onset time 52.8 ± 15.0 seconds with succinylcholine(1 mg/kg) compared to 102.6 ± 40.8 seconds and 163.2 ± 58.2 seconds with rocuronium (0.9 mg/kg and 0.6 mg/kg) respectively. These results are consistent with the findings in our study.

Verma et al[19] reported a clinical duration of 22.86 ± 4.9 minutes and 34.26 ± 5.6 minutes after (0.6 mg/kg) and (0.9 mg/kg) rocuronium respectively. Mirakhur et al[18] reported a clinical duration of 30.0 minutes and Weirda et al[28] reported a clinical duration of 33.0 minutes after (0.9 mg/kg) rocuronium. Booji et al[29] in their study reported a clinical duration of 17.4 ± 3.2 minutes after rocuronium(0.6 mg/kg). These observations are also in agreement with those of our study.

Verma et al[19] reported that increase in heart rate persisted upto 3 minutes in patients receiving succinylcholine(1.0 mg/kg), 4 minutes and 5 minutes in those receiving rocuronium(0.6 mg/kg and 0.9 mg/kg) respectively. Robertson etal[30] reported a 10 to 15% increase in mean arterial pressure and 5 to 10% increase in heart rate with (0.9 mg/kg) dose of rocuronium. Sparr et al[31] found maximum increase in the heart rate and mean arterial pressure of approximately 20% and 35% respectively following intubation after injecting rocuronium as the muscle relaxant and this returned to baseline values in 5 minutes. Shukla et al[21] observed no significant change in heart rate and mean arterial pressure from baseline values with succinylcholine(1.0 mg/kg) and rocuronium(0.6 mg/kg). However, they found slight increase in heart rate after the administration of relaxant in the rocuronium group but this difference was statistically insignificant. J. H. Levy et al[32] reported that rocuronium could be administered safely over a wide range of doses (0.6 mg/kg to 1.2 mg/kg) with minimal haemodyanamic effects or histamine release. These results are similar to those obtained in our study.

4. CONCLUSION

From our study it can be concluded that although succinylcholine is the neuromuscular blocking agent which produces early onset with excellent intubating conditions and has very short duration of action, but, because of its shortcomings rocuronium can be a good alternative. Rocuronium is a better and safer alternative to succinylcholine for rapid endotracheal intubation especially in patients where adverse effects of succinylcholine can be apprehended to produce serious consequences.

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