

Comparison of rocuronium at two different doses and succinylcholine for endotracheal intubation in adult patients for elective surgeries

ABSTRACT

Background: The effects of rocuronium at two different doses, that is, 0.6 mg/kg ($2 \times \text{ED}_{95}$) and 0.9 mg/kg ($3 \times \text{ED}_{95}$), were compared with succinylcholine (2 mg/kg) when used for endotracheal intubation in adult patients for elective surgeries under general anesthesia.

Materials and Methods: Ninety patients were divided into three groups of 30 each. Groups A, B received injection rocuronium at 0.6 mg/kg, 0.9 mg/kg respectively and Group C received succinylcholine at 2 mg/kg. Onset of action of relaxant, intubation conditions, time taken to intubate and duration of action were compared.

Statistical Analysis Used: To compare the statistical difference in the age, weight, height of the study subjects, onset of action of relaxant, intubation conditions, time taken to intubate, and duration of action analysis of variance and unpaired *t*-test were used.

Results: The onset time was considerably shorter with rocuronium 0.9 mg/kg than 0.6 mg/kg. The onset time of rocuronium 0.9 mg/kg was found to be significantly longer than succinylcholine 2 mg/kg. Time taken to intubate was shortest with succinylcholine 2 mg/kg. The time taken to intubate with the rocuronium 0.9 mg/kg was found to be comparable to that of rocuronium 0.6 mg/kg. Intubation score of rocuronium 0.9 mg/kg was the best (17.75), which was comparable with succinylcholine. However, the intubation score obtained with rocuronium 0.6 mg/kg was inferior. Duration of action was shortest with succinylcholine. The duration of action is prolonged when the dose of rocuronium is increased from 0.6 to 0.9 mg/kg.


Conclusion: Rapid sequence induction of anesthesia with propofol and fentanyl, succinylcholine allowed a more rapid endotracheal intubation sequence and created superior intubation conditions than rocuronium. However, the technique of using a large dose of rocuronium to achieve perfect conditions for tracheal intubation may have application whenever succinylcholine is relatively contraindicated.

Key words: Intubating conditions; intubating time; neuromuscular block; rocuronium; succinylcholine

Introduction

The need for a muscle relaxant with a rapid onset of action as succinylcholine became apparent due to some untoward side

effects of the latter drug. Such an agent would not have the side effects associated with depolarizing drugs (bradycardia, asystole, malignant hyperthermia, hyperkalemia, increased

Access this article online	
Website: www.saudija.org	Quick Response Code 
DOI: 10.4103/1658-354X.177330	

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Chavan SG, Gangadharan S, Gopakumar AK. Comparison of rocuronium at two different doses and succinylcholine for endotracheal intubation in adult patients for elective surgeries. Saudi J Anaesth 2016;10:379-83.

CHAVAN SG, GANGADHARAN S, GOPAKUMAR AK

Department of Anesthesiology, ESIC Medical College and Hospital, Parippally, Kollam, Kerala, India

Address for correspondence: Dr. Shirishkumar G. Chavan, Professor, Department of Anesthesiology, ESIC Medical College and Hospital, Parippally, Kollam, Kerala, India. E-mail: drshirishchavan@gmail.com

intraocular pressure, myalgia)^[1] and ideally its disposal would be independent of organ function.

Succinylcholine, the drug traditionally used to facilitate endotracheal intubation has been replaced by rocuronium. Rocuronium provides good intubation condition within 60 s of intravenous administration. Rocuronium has the most rapid onset of action among the currently available nondepolarizing neuromuscular blocking drugs.^[2] The rapid onset of action of rocuronium is believed to be primarily due to its low potency.^[3] Rocuronium was found to have no obvious side effects.^[4]

However, succinylcholine and rocuronium differ in their ability to provide excellent intubation conditions, the former being superior in this respect.^[5] A possible approach to improve the ability of rocuronium to produce perfect conditions for tracheal intubation would be to increase the dose administered.^[6]

In this study, the effects of rocuronium at two different doses, that is, 0.6 mg/kg (2 × ED95) and 0.9 mg/kg (3 × ED95), were compared with succinylcholine (2 mg/kg) when used for endotracheal intubation in adult patients for elective surgeries under general anesthesia.

Aims

To compare rocuronium at two different doses and succinylcholine for endotracheal intubation in adult patients for elective surgeries.

Primary objectives

To compare two doses of rocuronium with succinylcholine with regard to onset of endotracheal intubation and intubation conditions.

Secondary objectives

To compare two doses of rocuronium with succinylcholine with regard to time taken to intubate and duration of action.

Materials and Methods

Study period

Six months.

Study design

Double-blinded randomized control trial.

Study approval

The study was approved by the Institutional Medical Ethics Committee and written informed consent was obtained from all included patients.

Study population

Ninety patients were divided into three groups of 30 each.

Patient selection

All adult male patients aged 40 years or less, American Society of Anesthesiologists Grade I/II, with Mallampati score of up to Class II undergoing elective surgery under general anesthesia were included. Hyperkalemia, neurological disorders, burns, familial history of malignant hyperthermia, known or anticipated difficult intubation, known history of allergy to the drugs being used, severe or uncontrolled hypertension, diabetes, bronchial asthma, and epilepsy patients were excluded.

Study groups

Group A: Rocuronium 0.6 mg/kg,

Group B: Rocuronium 0.9 mg/kg and

Group C: Succinylcholine 2 mg/kg.

Three staff anesthesiologists assisted by an experienced anesthesia assistant were present throughout the procedure. Intubation was performed by senior staff anesthesiologist. This study involved the blinding of the drug loader, the drug administrator and anesthesiologist performing the intubation. The score of intubation was noted down.

Randomization

A computer-generated table of random numbers was prepared allotting equal number of patients in each group.

Study materials

Rocuronium, succinylcholine, Macintosh laryngoscope, endotracheal tube.

A thorough preanesthesia examination of the patient was conducted. Airway was assessed for intubation. All patients were kept fasting since the previous night. Oral premedication of tablet ranitidine 150 mg, tablet ondansetron 4 mg and tablet alprazolam 0.25 mg were given at 10 p.m. the day before surgery and at 6 a.m. on the day of surgery.

Electrocardiogram, pulse oximeter, peripheral nerve stimulator and noninvasive blood pressure monitor, end-tidal CO₂ (EtCO₂) monitor were attached. The patient vitals were checked and noted at every 5 min interval. Patients were placed in sniffing position to obtain the ideal intubation position.

Patients were preoxygenated for 3 min with 100% oxygen. Premedicated and induced with injection glycopyrrolate 0.2 mg, injection midazolam 1 mg, injection fentanyl 2 mcg/kg, injection 2% preservative free lignocaine 1 mg/kg, injection

propofol 2 mg/kg. Then, muscle relaxant to be studied, either Drug A or Drug B or Drug C was administered. Intubation was performed when “train of four (TOF) count” was 0. Endotracheal intubation was performed using a Macintosh size 4 blade and an endotracheal tube of adequate size.

Assessment

The intubation conditions were evaluated on the following criteria:^[7]

Criteria	Score 3	Score 2	Score 1
Laryngoscopy			
Jaw relaxation	Relaxed	Acceptable	Poor relaxation
Resistance to blade	None	Slight	Active resistance
Vocal cords			
Position	Abducted	Intermediate	Closed
Movement	None	Moving	Closing
Intubation response			
Limb movement	None	Slight	Vigorous
Coughing	None	Diaphragmatic	Severe coughing or bucking

After endotracheal intubation, the cuff was inflated and controlled ventilation was started. EtCO₂ monitor was attached. Immediately after tracheal intubation and serially thereafter, the number of tactile responses to TOF stimulation was recorded. The duration of action of the drug was taken as the time from injection until the return of the second tactile TOF response or 25% single twitch height.

After tracheal intubation, anesthesia was maintained with sevoflurane, N₂O, O₂, propofol and supplementation of muscle relaxant doses as required.

Statistical analysis used

To compare statistical difference in the age, weight, and height of the study subjects between the different groups, the analysis of variance (ANOVA) test was used and the *t*-test was used to compare Group A versus Group B, Group A versus Group C and Group B versus Group C as shown below.

Results

Three different groups of 30 each were labeled as Group A (rocuronium 0.6 mg/kg), Group B (rocuronium 0.9 mg/kg), and Group C (succinylcholine 2 mg/kg) [Table 1].

Table 1: Demographic profile

Parameter	A			B			C			P
	Mean	Median	Mode	Mean	Median	Mode	Mean	Median	Mode	
Age	29.20	28.50	40	32.65	35.50	40	33.80	36.00	36	2.309
Weight	57.35	55.00	55	54.00	55.00	50	58.00	60.00	60	1.734
Height	162.70	162.50	160	160.15	160.00	160	164.35	165.00	168	1.682

P > 0.05 statistically insignificant

The mean, median and mode of patients' age, weight and height were calculated between the three groups and were charted as shown above. Thus, it was concluded that the distribution of age, weight and height among the three groups were comparable and these factors did not have any influence on outcome.

Comparison of observations [Table 2]

- Time of onset: The onset time was assessed by the complete disappearance of all four twitches of adductor pollicis muscle to the TOF stimuli at the ulnar nerve
- Time to intubate: The time taken to intubate is taken as the time from the attainment of a zero TOF count up to endotracheal intubation
- Intubation score: The intubation score was calculated on a 6 point basis, each point being given a maximum score of 3 and a minimum score of 1. Thus, the cumulative score added up to a maximum of 18 being the best score and a minimum of 6, being the worst score
- Duration of action: The duration of action is taken from the administration of muscle relaxant up to the return of the second tactile TOF response or 25% single twitch height.

As per ANOVA, it was concluded that the onset time was considerably shorter with Group B than Group A. The onset time of Group B was found to be significantly longer than that of Group C.

Time taken to intubate was shortest with Group C. The time taken to intubate with the Group B was found to be comparable to that of Group A.

Intubation score of Group B was the best (17.75), which was comparable with Group C. However, the intubation score obtained with Group A was found to be inferior.

Duration of action is shortest with Group C. The duration of action is prolonged when the dose of rocuronium is increased from 0.6 (Group A) to 0.9 mg/kg (Group B).

As per unpaired *t*-test, difference in time to intubate is not significant in Group A and Group B. Difference in intubation score in Group B and Group C is not significant [Table 3].

Table 2: Comparison of observations

Observation	ANOVA test						
	A		B		C		P
	Mean	SD	Mean	SD	Mean	SD	
Time of onset	115.50	11.110	74.00	6.198	53.25	8.315	<0.001
Time to intubate	17.70	5.121	15.10	3.354	12.50	2.188	<0.001
Intubation score	16.70	0.865	17.75	0.550	17.70	0.571	<0.001
Duration of action	22.55	4.979	43.95	8.338	6.00	1.987	<0.001

P < 0.001 statistically significant. SD: Standard deviation; ANOVA: Analysis of variance

Table 3: Unpaired t-test

Observation	Unpaired t-test					
	Groups A and B		Groups A and C		Groups B and C	
	t-test	P	t-test	P	t-test	P
Time of onset	14.589	<0.001	20.062	<0.001	8.947	<0.001
Time to intubate	1.899	0.065*	4.176	<0.001	2.903	<0.001
Intubation score	-4.583	<0.001	-4.316	<0.001	0.282	0.780*
Duration of action	-9.855	<0.001	13.807	<0.001	19.800	<0.001

P < 0.001 statistically significant; *Not significant

Discussion

There are situations in anesthesia in which it may be desirable to achieve rapid tracheal intubation with perfect conditions, i.e., no coughing or straining. Succinylcholine, the drug traditionally used to facilitate rapid tracheal intubation has been replaced by rocuronium. Rocuronium, in doses of 0.6-1.2 mg/kg has proven to be as effective as succinylcholine 1 mg/kg in producing acceptable (good or excellent) conditions for rapid tracheal intubation. Rocuronium is the only approved nondepolarizing neuromuscular blocking drug with a rapid onset of action.^[8,9] The doses of rocuronium used in previous studies of rapid tracheal intubation have ranged from 0.6 to 1.2 mg/kg. Favorable intubating conditions were achieved in most patients with rocuronium and were comparable to succinylcholine.^[10] However, succinylcholine and rocuronium differ in their ability to provide excellent intubation conditions, with succinylcholine being superior in this respect. A possible approach to improve the ability of rocuronium to produce perfect conditions for rapid tracheal intubation would be to increase the dose administered.^[7]

Our goal in this study was to define doses of rocuronium that would provide perfect conditions for tracheal intubation in patients in whom succinylcholine was relatively contraindicated.^[7] An example of such a group of patients is trauma victims coming with severe head injury.^[11] In these patients, succinylcholine may be contraindicated because it may significantly increase intracranial pressure and serum potassium.^[12] Rocuronium, in contrast, does not increase intracranial pressure^[13] and because of its nondepolarizing

mechanism of action, will not increase serum potassium concentration.

Heier and Caldwell, found that rocuronium, in a dose of 2.0 mg/kg, can produce a >90% probability of achieving perfect conditions for rapid tracheal intubation. The use of such a large dose of rocuronium should be balanced against the consequences. Large doses will produce prolonged neuromuscular block. The median period of no tactile TOF response after rocuronium 2.0 mg/kg was approximately 2 h. Such a long duration makes the large dose rocuronium technique unsuitable in cases with short surgery time. However, if large doses are used in patients who will require prolonged tracheal intubation, such as those with head trauma, then prolonged block is not necessarily a disadvantage.^[11] The use of large doses of rocuronium also raises the issue of cost. This cost can be justified if obtaining perfect intubation conditions^[7] is a clinical priority and helps prevent an adverse patient outcome.

It was found that the onset time of rocuronium is faster at the laryngeal muscles than at the adductor pollicis.^[13] Complete neuromuscular block at the adductor pollicis muscle was found to be a nonessential prerequisite for optimal intubating conditions. The onset of action of rocuronium at the laryngeal adductor muscles is slower than that after suxamethonium, and the degree of the block is less intense.^[14] This may be because of the earlier blockade of laryngeal muscles than adductor pollicis by rocuronium.^[15]

In our study, onset time in the rocuronium 0.9 mg/kg group was prolonged than the succinylcholine group. As the dose of rocuronium increased from 0.6 to 0.9 mg/kg the onset time for neuromuscular blockade decreased.

When anesthesia was induced with propofol in elective cases, endotracheal intubation conditions were not different between succinylcholine and rocuronium approximately 60 s after the injection of the neuromuscular relaxant.^[7] A meta-analysis of the Cochrane collaboration concluded that when propofol is used to rapidly induce anesthesia, endotracheal intubation conditions are not statistically different between succinylcholine and rocuronium.^[16]

The time required for intubation was shorter with succinylcholine as compared to that of rocuronium. Succinylcholine created excellent intubation conditions than rocuronium, and there was a statistically significant difference of intubation conditions in favor of succinylcholine. However, as far as clinically acceptable intubating conditions and failed

intubation attempts are concerned, the two relaxants were not statistically different.

Adjustment of opioid or the use of increased doses of propofol may permit a high probability of successful tracheal intubation with smaller doses of rocuronium.^[17]

In conclusion, in the context of a rapid sequence induction of anesthesia with propofol and fentanyl in emergent cases, succinylcholine allowed a more rapid endotracheal intubation sequence and created superior intubation conditions than rocuronium. However, the use of rocuronium involves a long duration of neuromuscular block and significant drug cost. The technique of using a large dose of rocuronium to achieve perfect conditions for tracheal intubation may have application in situations in which succinylcholine is relatively contraindicated.

Conclusion

Onset time of rocuronium was less by 36% in Groups B than A with increase in dose from 0.6 to 0.9 mg/kg. The intubation score of rocuronium at a dose of 0.9 mg/kg was the best as compared to succinylcholine at 2 mg/kg. The time taken to intubate with rocuronium at 0.6 mg/kg and 0.9 mg/kg was found to be comparable. Rocuronium at 0.9 mg/kg has a longer duration of action than at a dose of 0.6 mg/kg. The onset time is 39% more prolonged with rocuronium at 0.9 mg/kg as compared to succinylcholine at 2 mg/kg. The time taken to intubate is the shortest with succinylcholine. The time taken to intubate with rocuronium at a dose of 0.6 mg/kg was 41% prolonged and with rocuronium at a dose of 0.9 mg/kg was 20% prolonged as compared with that of succinylcholine. The intubation conditions were found to be inferior with rocuronium at 0.6 mg/kg. The duration of neuromuscular blockade is shortest with succinylcholine. The duration of action with rocuronium at 0.6 mg/kg is 3.75 times that of succinylcholine and with rocuronium at a dose of 0.9 mg/kg is 7.5 times that of succinylcholine.

The distribution of age, weight, and height among the study groups even and they do not have any influence on the outcome.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Chiu CL, Jaais F, Wang CY. Effect of rocuronium compared with succinylcholine on intraocular pressure during rapid sequence induction of anesthesia. *Br J Anesth* 1999;82:757-60.
2. Marsch SC, Steiner L, Bucher E, Pargger H, Schumann M, Aebi T, *et al.* Succinylcholine versus rocuronium for rapid sequence intubation in intensive care: A prospective, randomized controlled trial. *Crit Care* 2011;15:R199.
3. Fuchs-Buder T, Sparr HJ, Ziegenfuss T. Thiopental or etomidate for rapid sequence induction with rocuronium. *Br J Anesth* 1998;80:504-6.
4. Dubois MY, Lea DE, Kataria B, Gadde PL, Tran DQ, Shearrow T. Pharmacodynamics of rocuronium with and without prior administration of succinylcholine. *J Clin Anesth* 1995;7:44-8.
5. Sparr HJ, Luger TJ, Heidegger T, Putensen-Himmer G. Comparison of intubating conditions after rocuronium and suxamethonium following "rapid-sequence induction" with thiopentone in elective cases. *Acta Anesthesiol Scand* 1996;40:425-30.
6. Heier T, Caldwell JE. Rapid tracheal intubation with large-dose rocuronium: A probability-based approach. *Anesth Analg* 2000;90:175-9.
7. Sluga M, Ummenhofer W, Studer W, Siegemund M, Marsch SC. Rocuronium versus succinylcholine for rapid sequence induction of anesthesia and endotracheal intubation: A prospective, randomized trial in emergent cases. *Anesth Analg* 2005;101:1356-61.
8. Tryba M, Zorn A, Thole H, Zenz M. Rapid-sequence orotracheal intubation with rocuronium: A randomized double-blind comparison with suxamethonium — preliminary communication. *Eur J Anesthesiol Suppl* 1994;9:44-8.
9. Crul JF, Vanbelleghem V, Buyse L, Heylen R, van Egmond J. Rocuronium with alfentanil and propofol allows intubation within 45 seconds. *Eur J Anesthesiol Suppl* 1995;11:111-2.
10. Huizinga AC, Vandenbrom RH, Wierda JM, Hommes FD, Hennis PJ. Intubating conditions and onset of neuromuscular block of rocuronium (Org 9426); a comparison with suxamethonium. *Acta Anesthesiol Scand* 1992;36:463-8.
11. Silber SH. Rapid sequence intubation in adults with elevated intracranial pressure: A survey of emergency medicine residency programs. *Am J Emerg Med* 1997;15:263-7.
12. Frankville DD, Drummond JC. Hyperkalemia after succinylcholine administration in a patient with closed head injury without paresis. *Anesthesiology* 1987;67:264-6.
13. Schramm WM, Strasser K, Bartunek A, Gilly H, Spiss CK. Effects of rocuronium and vecuronium on intracranial pressure, mean arterial pressure and heart rate in neurosurgical patients. *Br J Anesth* 1996;77:607-11.
14. Naguib M, Samarkandi AH, Ammar A, Turkistani A. Comparison of suxamethonium and different combinations of rocuronium and mivacurium for rapid tracheal intubation in children. *Br J Anesth* 1997;79:450-5.
15. Barve M, Sharma R. Comparison of intubating conditions and time course of action of rocuronium bromide and succinylcholine in paediatric patients. *Indian J Anesth* 2002;46:465-8.
16. Perry JJ, Lee JS, Sillberg VA, Wells GA. Rocuronium versus succinylcholine for rapid sequence induction intubation. *Cochrane Database Syst Rev* 2008;16;2:CD002788.
17. Stevens JB, Vescovo MV, Harris KC, Walker SC, Hickey R. Tracheal intubation using alfentanil and no muscle relaxant: Is the choice of hypnotic important? *Anesth Analg* 1997;84:1222-6.