EVALUATION OF INTUBATING CONDITIONS IN PAEDIATRIC PATIENTS- A COMPARATIVE STUDY OF SUCCINYLCHOLINE AND TWO DIFFERENT DOSES OF ROCURONIUM

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ABSTRACT

BACKGROUND

The need for a muscle relaxant with rapid onset of action as Succinylcholine (Sch.) became apparent due to some untoward side effects of Sch. Rocuronium has the most rapid onset of action among the currently available agents and found to have no obvious side effects. Though both Sch. and Rocuronium provide excellent intubating conditions, the former is superior. A possible approach to improve the ability of rocuronium to produce perfect conditions for intubation would be to increase the dose administered.

MATERIALS AND METHODS

This non randomized control trial study was conducted on 75 patients of age 1-10 years, American Society of Anesthesiologists (expand) grade I and grade II devoid of any other comorbidities, undergoing elective surgeries after taking informed parental consent. Patients had either Mallampati class I and II divided in three groups 25 each. Sample size was calculated for convenience.

RESULTS

In GpA 96% (24 Pts), in GpB 52% (13 pts) and in GpC 76% (19 pts) showed excellent intubating conditions. Onset time was least in GpA i.e. 54.12 sec while it was 135.2 sec in GpB and 90.20 sec in GpC. There was statistically significant difference of lag time between GpA and GpB and in GpB and GpC while no difference in GpA and GpC. In terms of twitch height, onset time, clinical duration and recovery index, no significant difference was observed among all three groups.

CONCLUSION

Rocuronium in the dose of 0.9 mg/kg is an acceptable alternative of Sch. for rapid and excellent intubating conditions without any untoward side effects.

KEY WORDS

Intubating Conditions, Neuromuscular Block, Succinylcholine, Rocuronium, RSI

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BACKGROUND

Endotracheal intubation is an integral part of the anaesthesiologist's contribution in the patient care. The ability to intubate trachea rapidly and safely is of paramount importance for every patient, especially who need a rapid sequence induction to protect against aspiration. Rapid sequence induction (RSI) technique involves prompt sequential administration of a predetermined dose of hypnotic agent and muscle relaxant followed by tracheal intubation.

Sch. is a neuromuscular blocking agent (NMBA) has been traditionally the most commonly used drug for RSI in both routine and emergency settings. Its rapid onset (40 – 60 sec) and short duration of action (6-10 min) make it a first choice.

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But due to some untoward side effects associated with Sch. like hyperkalaemia, bradyarrythmias, increase intraocular and intracranial pressures and malignant hyperthermia, need of a muscle relaxant with a rapid onset and short action as Sch. became apparent, which is free of side effects, non-cumulative, no histamine release, early reversible and ideally its disposal would be independent of organ failure.[1,2]

The search for NMBA which fulfilled these requirements lead to discovery of rocuronium (Amonoquartenary steroid analogue) with a rapid onset, intermediate duration of action and relatively of low potency.[3-4] It represents a major step forward in meeting the requirements of an "Ideal Muscle Relaxant" which provides an excellent endotracheal intubating conditions in 60 secs.

A 2ED95 dose of rocuronium is recommended to facilitate tracheal intubation where 90 % suppression of single twitch response is usually considered as adequate surgical relaxation. Studies have shown that rocuronium provides adequate intubating conditions comparable to Sch. in adults. This study was conducted to compare the intubating conditions using Sch. and two different doses of rocuronium at 1 min interval and to evaluate and compare the onset and clinical duration of neuro muscular blockade.

Aims and Objectives

Our aim is to compare the intubating conditions, onset of neuromuscular blockade and clinical duration of action of Succinylcholine and in two different doses of Rocuronium bromide.

MATERIALS AND METHODS

This non randomized control trial study was conducted in our Department of Anaesthesia on 75 patients aged 1-10 years of ASA grade I and grade II undergoing elective surgery after taking due permission from hospital ethical committee and informed parental consent. Sample size was taken for convenience.

The Exclusion Criteria were children suspected of neuro muscular disorders, metabolic diseases, impaired kidney and liver functions and whose body weight deviated by more than 20% from the ideal for their height and age. All children enrolled had either Mallampati class I or II and no contraindication for rapid sequence induction of anaesthesia.[5-8] Pre-Anaesthetic Check-up (PAC) and necessary investigations done on the day before surgery to ascertain the medical and physical fitness. Selected patients were divided into Three Groups. The groups were allocated by non-randomization, the computerised non-randomization chart was prepared by the statistician. Group A (GpA) received Inj. Sch. 1 mg/kg, Group B (GpB) received inj. Rocuronium 0.6 mg/kg [2ED95] and Group C (GpC) received inj. Rocuronium 0.9 mg/kg [3ED95] after premedication with inj. glycopyrrolate 0.005 mg/kg, inj. midazolam 0.07 mg/kg and inj. fentanyl 2 mcg/kg. Preoxygenation with 100% O_2 done and induction done with inj. Thiopentone sodium (2.5%) 4-6 mg/kg. After that neuromuscular agents were given to their respective groups. Neuromuscular transmission was monitored by using TOF-guard.[9] The supramaximal stimulus of duration of 0.2 ms and frequency 2 Hz were delivered in a Train of Four (TOF) sequence at 12 sec intervals to the ulnar nerve. The First of the Four Evoked response was considered as twitch height.

After administration of muscle relaxant, response to the completion of tracheal intubation were recorded

1. Lag Time: Time between administration of relaxant and first measurable neuromuscular effect. (Twitch depression >5% of control value)
2. Twitch height at 1 minute.
3. Onset Time: Time between administration of relaxant and maximum twitch depression.
4. Clinical Duration: Time between administration and recovery to 25% twitch height.
5. Recovery Index: Time of recovery of twitch response from 25-75%.

Statistical Analysis

Mean and standard deviations of all the parameters were calculated out. Statistical analysis was done using SPSS– Version 21. Unpaired 't' test was done to calculate the p-value ($p < 0.05$ was considered significant). To compare the mean of three groups we used Analysis of Variance (ANOVA). In order to compare the difference between three means, one-way ANOVA should be used instead of unpaired t test. If the difference is statistically significant in one-way ANOVA, relevant post hoc test has to be conducted to know about the group that is significantly contributing to the difference. The tests used are-

Train of Four (TOF)

Expand in TOF four supramaximal stimuli are given every 0.5 sec. that is, at a frequency of 2 Hz.

Each set (train) of stimuli is repeated every tenth to twelfth sec. When used continuously. It is used to

1. To judge the onset of blockade.
2. To judge the depth of block.
3. To judge the adequacy of recovery from block.

Twitch Height

Twitch height at 1 minute denotes the percentage of neuromuscular block at the adductor pollicis muscle of thumb recorded at the time of intubation.

Onset Time

It defined as time between administration of relaxant and maximum twitch depression.

Score	Jaw Relaxation	Vocal Cords	Response to Intubation
0	Poor (Impossible)	Closed	Severe Coughing and Bucking
1	Minimal (Difficult)	Closing	Mild Coughing
2	Moderate (Fair)	Moving	Slight Diaphragmatic Movements
3	Good (Easy)	Open	No Diaphragmatic Movements

Intubating Conditions at 60 Seconds

Overall Score	Grade
8-9	Excellent
6-7	Good
4-5	Fair
0-3	Poor

Grading of Intubating Conditions

RESULTS

	GpA	GpB	GpC
Age (Years) Mean ± S.D.	5.92 ± 2.56	5.72 ± 2.73	5.84 ± 2.54
Sex (M:F) Ratio	13:12	11:14	16:9
Weight (Kg) Mean ± S. D.	19.40 ± 6.63	18.92 ± 6.75	19.16 ± 6.78

Table 1. Demographic Profile

*We have written mean with standard deviation only. The mean demographic and clinical characteristics of the patients under study were comparable among the three groups. There were more males as compared to females in GpA and GpC and was inverse in GpB.

Grading of Intubating Condition	Score	Gp A	Gp B	Gp C
Excellent	8-9	24 (96%)	13 (52%)	19 (76%)
Good	6-7	1 (4%)	6 (24%)	6 (24%)
Fair	4-5		4 (16%)	
Poor	0-3		2 (8%)	

Table 2. Grading of Intubating Condition

Authors can apply Fischer's exact test for the above-mentioned table. In table No. 2 parameters are subjective. In

table 3 & 4 we have compared the parameters among three groups using ANOVA test.

In GpA 96% Showed excellent intubating conditions at 60 secs, while in GpB 52% showed excellent, 24% good, 16% fair and 8% showed poor intubating conditions. In GpC the intubating conditions were excellent in 76% and good in 24% in all cases. All patients were intubated at 60 secs in GpA and GpC.

	GpA	GpB	GpC	p Value
Lag Time (in sec)	15.40 ± 3.96	25.64 ± 11.09	16.80 ± 6.14	0.001
Twitch Height at One Minute (%)	1.2 ± 6	33.80 ± 14.91	15.72 ± 14.00	0.014
Onset Time (sec)	54.12 ± 8.87	135.12 ± 37.38	90.20 ± 36.61	0.022
Clinical Duration	4.76 ± 0.93	27.96 ± 4.39	37.84 ± 6.30	0.018
Recovery Index	5.04 ± 0.73	4.92 ± 0.76	4.72 ± 0.79	0.016

Table 3. Neuro Muscular Blockade Parameters

Mean Lag time in GpA was 15.40 sec, in GpB 25.64 sec & in GpC 16.80 sec. In GpA, Twitch height at 1 minute was zero in all patients except one, mean was 1.2%. In GpB the mean Twitch height was 33.8% and in GpC 15.72%. The mean onset time in GpA was 54.12 sec ranged between 35 to 71 sec. In GpB it was 135.12 sec with a ranged of 90 to 210 sec while in GpC it was 90.20 sec, ranged between 25 to 150 sec. The mean clinical duration in GpA was 4.76 minutes and ranged between 3-6 minutes, while in GpB it was 27.96 minutes with a ranged of 21-36 minutes, in GpC it was 37.84 minutes, ranged between 20-50 minutes. In GpA mean recovery index was 5.04 min, in GpC 4.92 min and in GpC it was 4.72 min.

	Lag Time	Twitch Height at 1 Minute	Onset Time	Clinical Duration	Recovery
GrA Vs GrB	.0008 (HS)	.0006 (HS)	.0009 (HS)	.0008 (HS)	.08 (NS)
Gr A Vs GrC	.06 (NS)	.0006 (HS)	.0006 (HS)	.0008 (HS)	.07 (NS)
GrB Vs GrC	.007 (HS)	.0005 (HS)	.0009 (HS)	.0004 (HS)	.07 (NS)

Table 4. Inter Group Comparison (p Value)

'P' value >.05 was considered as significant.

There was statistically significant difference of lag time between GrA & GrB and in GrB and GrC while there was no significant difference between GrA and GrC. In terms of twitch height at one min, for onset time and clinical duration there was statistically significant difference among all the three groups under study. For recovery index no significant difference observed among all three groups under study. Recovery index was similar in all three groups.

DISCUSSION

In describing the characteristics of an ideal NMBA, Savarese and Ketz in 1973 pointed out the importance of fast and short duration of action, lack of cumulation, cardiovascular stability, early reversibility, devoid of histamine release, drug interactions and absence of active metabolites.[10]

Sch. which is a fairly satisfactory NMBA partly fulfilling the above criteria is not free from side effects. Rocuronium is a NDMR which provides an alternative to Sch. in terms of onset and duration of action. It allows early intubation with nearly all properties of an ideal NDMR which is free from cardiovascular side effects and have sufficient versatility to be used in routine clinical anaesthesia.

In present study all patients were comparable in terms of demographic profile. They are of age group 1-10 years and ASA grade I and grade II, not having any cardiovascular, renal or neuromuscular dysfunction. T. Fuchs-Buder et al had conducted study on intubating conditions and time course of rocuronium adopted similar selection criteria.

In our study intubating conditions were assessed by three parameters ie, jaw relaxation, vocal cord relaxation, and reaction to intubation. Intubation was performed at 60 secs when good to excellent intubating conditions present otherwise further attempt was made after 30 secs and these patients graded as having fair to poor intubating conditions.

In our study in GpA and GpC all the patients were successfully intubated at 60 secs with 72% having excellent intubating conditions in GpC and 96% in GpA while in GpB 19 patients were intubated under excellent (52%) and good (24%) conditions and rest 6 (24%) couldn't be intubated in 60 secs.

MC Court KC et al in their study concluded that intubating conditions for rocuronium 0.6 mg/kg was poor in 25% of cases. Similar results were found with Ablouleish E et al and Fusch Buder T et al. They also support the same results.

Lag time is defined as time between administration of relaxant and the first measurable neuromuscular effect. In our study the mean lag time of GpA and GpC was 15.40 secs and 16.80 secs. respectively, which was statistically similar. GpB showed higher lag time of 27.48 secs. Similar finding of higher lag time was found in study conducted by Hopkinson JM et al and Wierda et al.

Twitch height at 1 minute denotes the percentage of neuromuscular block at the adductor pollicis muscle of thumb recorded at the time of intubation. We studied a correlation between twitch height at 1 minute and intubating conditions because, for rapid sequence induction intubation within 60 secs is an important intubation criterion. In GpA twitch height at 1 min was zero in all patients except one whose twitch height was 30 % which is in accordance with excellent intubating conditions. In GpB 76% patients had excellent or good intubating conditions, the mean twitch height at 1 minute was 33.8%. Fair to poor intubating conditions were observed in 24 % of patients. These results are similar with those of C. Meistelman et al who observed reliable paralysis of laryngeal muscles. In addition, Folds et al and Wierda et al noted coughing after rocuronium 0.6 mg/kg. Hence, we speculated that the recommended dose for tracheal intubation of rocuronium 0.6 mg/kg will not always have complete diaphragmatic and vocal cord paralysis. In GpC the mean twitch height was 15.7 % resulted in excellent to good intubating conditions. Reason for this may be the degree of neuromuscular block was observed at the adductor pollicis muscle that does not necessarily reflect those appearing in other sides in the body. Magorian et al in their study concluded that optimal intubation condition was obtained with 0.6, 0.9, 1.2 mg/kg rocuronium one minute after muscle relaxant administration and were similar to

conditions achieved with suxamethonium. However, if the criterion for rapid sequence induction of anaesthesia is complete neuromuscular blockade at the time of tracheal intubation, then only doses of 0.9 and 1.2 mg/kg rocuronium were adequate.

Onset time is defined as time between administration of relaxant and maximum twitch depression. The mean onset time in GpA was 54.12 seconds. Whereas it was high as 135.12 seconds for GpB while in GpC it was 90.20 seconds. In our study in GpA complete blockade was achieved in less than 90 seconds while in GpB and GpC, Onset of blockade followed a biphasic pattern. There was a rapid fall in twitch response >80% during initial 70 seconds followed by slow response for ultimate 20%. This may possible explain the excellent intubating conditions soon after the administration of rocuronium due to the low neuromuscular blocking potency of rocuronium which result in a higher molecular load, being present at the neuromuscular junction, producing an initial high concentration gradient and transfer of molecules of drug to the biophase. These finding of ours is in accordance with that given by Cooper et al. Similar results about onset time and intubating conditions were found partly in the same Mirakhur et al, Huizinga et al and partly in other studies (Dubois et al, Wierda et al)in which intubation was attempted 90 secs after administration of relaxant.

In our study mean clinical duration for GpA was 4.76 minutes with a range of 3-6 minutes, while in GpB the mean clinical duration was 27.96 minutes with a range of 21-36 minutes and for GpC it was 37.84 minutes which ranged between 20-50 minutes. In Fuchs Buder et al study the clinical duration was 21 minutes for patient intubated with 0.6 mg/kg and 34 minutes for patient intubated with 0.9 mg/kg. The findings of Khuenl Brady KS et al were in accordance with our study. They recorded clinical duration of 26.9 minutes for rocuronium 0.6 mg/kg and similar results about clinical duration were found in study conducted by Huizinga ACT et al. Hence, we can speculate that the clinical duration of action of rocuronium is intermediate after both 0.6 and 0.9 mg/kg rocuronium. Increasing the dose of rocuronium also increased the clinical duration. This increase was statistically significant but is not clinically relevant as the profile of the drug does not change. Moreover, the recovery index was not affected by increase in dose. These results are in accordance with those reported in the same age group by Woelfe L and Colleagues.

Recovery Index is the time required for recovery of twitch height from 25 to 75 %. In our study reversal agent Inj neostigmine and Inj glycopyrrolate were administered at 25 % of twitch height and in all the three groups recovery to 75 % of twitch height was achieved within 5 minutes. The mean recovery index of GpA was 5.04 minutes for GpB it was 4.92 minutes and for GpC it was 4.72 minutes.

These findings are same as Vanden Broek et al. They compared spontaneous and neostigmine induced parameters for rocuronium and found that spontaneous recovery time was 14.2 minutes while neostigmine induced recovery index was 4.1 minute. Similar results were found in studies conducted by Naguib et al and Davis et al. So, we found that Rocuronium at 0.6 mg/kg dose (2ED95) provides acceptable intubating conditions. By increasing the dose of rocuronium from 2ED95 to 3ED95 (0.9 mg/kg) provides better intubating conditions within 60 secs specially in RSI as Sch. Rocuronium can be safely used as an alternative to Sch. during RSI specially in patients who are at risk of adverse effects of Sch.

CONCLUSION

Rocuronium in the dose of 0.9 mg/kg is an acceptable alternative of Sch. for rapid and excellent intubating conditions without any untoward side effects.

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