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Research Article

Rocuronium versus succinylcholine: a clinical comparison of two muscle relaxants for rapid sequence induction of anaesthesia

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ABSTRACT

Background: In emergencies, some cases need a general anaesthetic with endotracheal intubation. It is imperative to have fast acting medications to allow clinicians to complete this procedure quickly and safely. Succinylcholine is currently the most used muscle relaxant. It is fast acting and lasts only for a few minutes and is very desirable in such settings. In certain cases, succinylcholine cannot be used as it causes disturbances in salt balance such as hyperkalaemia and other adverse reactions. An equally effective anaesthetic without such undesirable side effects would be advantageous. One such possible alternative is rocuronium, a muscle relaxant which has fewer side effects but a longer duration of action. Our study compares rocuronium versus succinylcholine for rapid sequence induction of anaesthesia.
Methods: 80 adult cases ranging in age from 20 to 50 years with ASA Grade I & II, Mallampatti Grade I and II and requiring emergency surgery under general anaesthesia were selected for this study. Cases were randomly allocated into 2 groups containing 40 cases each. Cases in Group I received Succinylcholine 2mg/kg body weight and those in Group II received rocuronium 0.6mg/kg body weight.
Results: Succinylcholine is still the drug of choice in emergencies where rapid sequence of anaesthesia is needed for intubation with rapid onset, rapid recovery and profound relaxation. The action profile of Succinylcholine is unmatched even 50 years after its introduction into anaesthetic practice. This is probably why Succinylcholine, despite its many adverse effects and partly life-threatening side effects, is still considered indispensable by many anaesthetists and emergency doctors. To avoid the complications of Succinylcholine many new and old non-depolarizing drugs have been tried but Succinylcholine still remains the drug of choice for tracheal intubation in emergencies and full stomach.
Conclusions: Both rocuronium and succinylcholine are effective and potent muscle paralytic agents. Rocuronium has emerged as the muscle relaxant of choice in only in cases where Succinylcholine is contraindicated. Succinylcholine remains the anaesthetic medication of choice for rapid induction in adults. An ideal anaesthetic neuromuscular blocking agent should have properties similar to Succinylcholine.

Keywords: Endotracheal intubation, Muscle relaxant, Rocuronium, Succinylcholine

INTRODUCTION

Rapid sequence induction (RSI) is the technique of endotracheal intubation to secure the airway of a patient rapidly and safely. It applies to virtually all attempts for endotracheal intubation (ET) in the emergency department (ED) except for arrest situations. Para Vertebral Space Injection (PVSI) is particularly preferred for ED use because of the simultaneous onset of sedation, paralysis and minimizing the risk of aspiration. After

being launched in the late seventies, the procedure has been dynamically changing in time with introduction of many newer and advantageous agents. Patients suspected to have a full stomach are associated with increased risk of aspiration during anaesthesia.[1,2] The factors for full stomach include critical illness, emergency surgery, Caesarean section, trauma, airway difficulties, inadequate depth of anesthesia, and gastrointestinal disorders such as intestinal obstruction, hiatus hernia, and gastro-oesophageal reflux disease.[2,3] Such are risked with regurgitation, vomiting and pulmonary aspiration of gastric contents. Pulmonary aspiration remains an infrequent but serious cause of anesthesia-related morbidity and mortality, with little change in incidence over the past 20 years. In a study of 133 cases of aspiration reported to the Australian Anesthetic Incident Monitoring Study database, 56% of the cases of pulmonary aspiration occurred during the induction of anesthesia, the goal of RSI is to prevent pulmonary aspiration of gastric contents. One of the important factors for aspiration prevention is minimization of the induction intubation interval.[4] The time interval from the suppression of protective reflexes by induction to accomplishment of intubation is a critical period, during which regurgitation and tracheobronchial aspiration of acid gastric contents can occur most frequently.[4,5] Protection can be achieved by the administration of a short acting hypnotic agent followed by a rapid onset neuromuscular blocking agent.[5] The ideal neuromuscular blocking agent for rapid sequence intubation should have a fast onset, brief duration of action, provide profound relaxation and be free from haemodynamic changes. Succinylcholine is the gold standard muscle relaxant for rapid sequence intubation.[6] Traditionally, Succinylcholine, a depolarizing neuromuscular blocking agent, has been the drug of choice for rapid sequence induction of anesthesia. Succinylcholine has a very rapid onset and is a short acting agent producing profound muscle relaxation for tracheal intubation. However, Succinylcholine can have serious side effects like fasciculations leading to rise in intra-abdominal, intragastric, intracranial & intraocular pressures and their consequences, hyperkalaemia resulting in possibility of cardiac dysrhythmias and arrest, malignant hyperthermia, muscle damage and postoperative myalgia.[7,8] So it is contraindicated in many conditions like post burn, prolonged immobilization & bed rest etc. Therefore, many studies have investigated for a suitable alternative to Succinylcholine. In an effort to avoid the adverse reactions associated with Succinylcholine or when contraindicated, non-depolarizing agents have been investigated for their efficacy during intubation. But none of the non-depolarizer substitutes available, including drugs of intermediate duration like Atracurium or Vecuronium for Succinylcholine have been found to be effective with consistent results.[8] Newer, rapidly acting agents like Rocuronium and Mivacurium have given promising results in rapid sequence intubation but their unavailability and high cost limit their routine use. Rocuronium has the most rapid onset among the currently available non-depolarizing neuromuscular blocking drugs.[8] Rocuronium is the only non-depolarizing neuromuscular blocking agent with an onset similar to Succinylcholine. The side effect profile is much less problematic than Succinylcholine. The duration of action is much longer than Succinylcholine, and in patients with an increased risk of difficult airway, Rocuronium is not as attractive as Succinylcholine during airway difficulties. It provides good intubation condition within 60 seconds of intravenous administration. Rocuronium may act with other non-depolarizing muscle relaxants synergistically without any adverse effect.[8] It is currently not established whether endotracheal intubation conditions obtained at the actual moment of intubation under Succinylcholine differ from those obtained 60 seconds after the injection of rocuronium. Accordingly, the aim of the present study was to compare rocuronium with the current practice of the use of Succinylcholine (endotracheal intubation as soon as possible) in patients requiring rapid sequence induction of anesthesia and endotracheal intubation for emergency surgeries.

METHODS

The present study was carried out in the Department of anaesthesiology, Patna Medical College and Hospital, Katihar. After obtaining ethical clearance from the institution 80 adult cases ranging in age from 20 to 50 years with ASA Grade I & II, Mallampatti Grade I and II and requiring emergency surgery under general anaesthesia were selected for this study. Cases were randomly allocated into 2 groups containing 40 cases each. Cases in Group I received Succinylcholine 2mg/kg body weight and those in Group II received Rocuronium 0.6mg/kg body weight. Both drugs were administered intravenously just after induction of anaesthesia.

Inclusion criteria

All emergency cases requiring emergency surgery in emergency department

Exclusion criteria

- Cases who did not want to participate in this study.
- Cases with history suggestive of cardio-respiratory illness.
- Cases with history of drug sensitivity to the drugs in this study.
- Cases with spinal degeneration or muscular disorders.
- Cases with prolonged immobilization, burn and renal failure.
- Cases with existing increased intracranial or intraocular pressure.
- Cases with crush injury, head injury or penetrating injury.
- Cases with genetic disorders such as malignant hyperthermia or pseudocholinesterase deficiency.
- Cases with anticipated difficult intubation.

Routine anaesthetic instruments were required for this study however instruments that could be required in cases of difficult intubation and pulmonary aspiration was kept ready. The drugs were administered as Inj. Succinylcholine 50mg/ml and Inj. Rocuronium 10mg/ml respectively. No premedication was administered in any case. Upon arrival in the operating theatre, 18-gauge cannula was inserted in a forearm vein. Monitors for HR, ECG, N1BP, SpO2, and End Tidal CO2 were attached and preoperative pulse, BP, SpO2 were noted. The endotracheal intubation sequence was defined as time interval between the injection of Thiopentone and successful intubation performed. After 3 min of the administration of 100% oxygen, the anesthesia was induced with 2.5% Thiopentone slowly increased until loss of consciousness. Simultaneous to induction of anesthesia, the cricoid pressure was started and slowly increased until loss of consciousness and maintained until endotracheal intubation and cuff inflation. The neuromuscular blocking drug was injected as soon as the eyelash reflex had disappeared. The time was noted as zero time. 100% oxygen by facemask was continued until respiration had stopped completely. Laryngoscopy was started either after the cessation of fasciculations in the lower extremities or after 50 seconds (anticipated time of intubation 60 seconds after the injection of the neuromuscular blocking drug), whichever was earlier and if found unsatisfactory, lungs were ventilated with 100% oxygen and patients were re-assessed at further intervals of 30 seconds (90 seconds, 120 seconds, 150 seconds, 180 seconds) and till the intubating conditions were found to be good to excellent. The intubating conditions was graded using Cooper scoring system and signs of histamine release.

RESULTS

80 adult cases ranging in age from 20 to 50 years with ASA Grade I & II, Mallampatti Grade I and II and requiring emergency surgery under general anaesthesia were selected for this study. Cases were randomly allocated into 2 groups containing 40 cases each. Cases in Group I received Succinylcholine 2mg/kg body weight as Inj. Succinylcholine 50mg/ml respectively and those in Group II received Rocuronium 0.6mg/kg body weight as Inj. Rocuronium 10mg/ml. Table 1 shows that the cases in both groups were comparable on the basis of mean age in years and SD.

Table 1: Age distribution among cases of both groups.

Group	Age in years	Mean age	SD
I	20-50	36.25	9.83
II	20-50	36.42	9.28

Table 2 shows that cases in both groups were comparable on the basis of sex ratio.

Table 2: Sex distribution among cases of both groups involved in this study.

Group	Males	Females	Total
I	21	19	40
II	26	14	40

Table 3 shows that cases in both groups were comparable on the basis of body weight distribution.

Table 3: Body weight distribution among cases of both groups.

Group	Body weight range (Kg)	Mean weight (Kg)	SD
I	45-74	58.23	8.13
II	40-75	55.96	6.75

Table 4 shows that the surgeries performed in both the groups were comparable on the basis nature of surgery.

Table 4: Nature of surgery performed in both groups.

Group	No. of cases	Surgery	Drug
I	40	06 – Trauma care 12 – LSCS 22 – Laparotomy	Succinylcholine
II	40	06 – Trauma care 10 – LSCS 24 – Laparotomy	Rocuronium

From Table 5 it was observed that the mean onset time in Group I patients was 64.5 seconds with a SD of 10.84 and that Group II patients was 71. 5 seconds with an SD of 17.56. There was a significant difference between onset time in Group I and II, which is revealed, by wide difference in SD.

Table 5: Time onset of anaesthesia after drug administration.

Group	Range (Sec)	Mean (Sec)	SD
I	60-90	64.5	10.84
II	60-120	71.5	17.56

Table 6 explains the mean intubation score at 60 seconds was 7.95 (1.39) and 7.45 (1.69) in Group I and II respectively.

Table 6: Intubation score during laryngoscopy.

Group	Range	Mean	SD
I	4-9	7.95	1.39
II	3-9	7.45	1.69

Table 7: Comparison of blood pressure among cases in both groups.

Group	I			II		
Parameters	**Mean**	**Range**	**SD**	**Mean**	**Range**	**SD**
Before Intubation	85.15	77-99	9.99	87.97	73-99	7.95
Just After Intubation	96.75	73-123	12.35	104.72	83-123	14.34
5 mins After Intubation	88.40	76-107	6.24	93.97	81-108	8.39
10 mins After Intubation	87.92	77-99	5.99	90.62	81-107	7.01
20 mins After Intubation	84.87	75-94	4.36	84.22	77-94	4.22
30 mins After Intubation	83.47	77-99	4.18	84.12	80-88	2.34

Table 8: Comparison of SpO_2 among cases in both groups.

Group	I			II		
Parameters	**Mean**	**Range**	**SD**	**Mean**	**Range**	**SD**
Before Intubation	97.85	93-100	1.62	97.72	94-100	1.66
Just After Intubation	98.92	92-100	1.69	98.36	94-100	1.74
5 mins After Intubation	99.72	96-100	0.72	99.82	99-100	0.38
10 mins After Intubation	99.82	99-100	0.38	99.87	94-100	0.34
20 mins After Intubation	99.82	99-100	0.38	99.18	99-100	0.15
30 mins After Intubation	99.82	99-100	0.38	99.86	99-100	0.26

Table 9: Comparison of heart rate among cases in both groups.

Group	I			II		
Parameters	**Mean**	**Range**	**SD**	**Mean**	**Range**	**SD**
Before Intubation	76.15	66-110	10.05	75.07	65-91	8.78
Just After Intubation	90.12	56-120	13.77	93.22	60-122	17.37
5 mins After Intubation	81.35	60-100	9.16	82.15	64-96	8.54
10 mins After Intubation	77.22	66-96	7.22	77.95	66-98	9.55
20 mins After Intubation	74.33	60-90	6.16	72.97	60-86	7.62
30 mins After Intubation	72.95	68-88	4.59	73.67	61-108	9.34

Table 10: Adverse effects at the time of laryngoscopy.

Adverse Effect	Group I		Group II	
Bradycardia	01	2.5%	01	2.5%
Tachycardia	17	42.5%	24	60%
Laryngospasm	02	5%	01	2.5%
Arrhythmia	00	00	00	00
Others	00	00	00	00
Nil	18	45%	14	35%

From Table 7 it was observed that there were no significant differences among blood pressure readings among cases of both groups. However the mean blood pressure was lower in Group I patients just after intubation and 5 mins after intubation. This difference was significant. Table 8 shows that SpO2 was lower in Group II just after intubation. This difference was significant. Other parameters related to SpO2 were similar in both groups.

Table 9 exhibits that mean heart rate was higher in Group II just after, 5 mins after and 10 mins after intubation. From Table 10 describes that there were no significant adverse effects that occurred at the time of intubation among the cases in either group.

DISCUSSION

An ideal muscle relaxant should have non-depolarizing mechanism of action, rapid onset, short duration, rapid recovery, non-cumulative, anti-histaminic release, no cardiovascular side effects, high potency, and prompt reversibility by cholinesterase inhibitors and pharmacologically inactive metabolites. Traditionally Succinylcholine has been the neuromuscular blocking drug of choice for rapid sequence induction (RSI) and

minimizing the chances of regurgitation and aspiration.[9-11] The use of Succinylcholine can however be associated with many side effects.[12-14] Hence, a non-depolarizing neuromuscular blocker with a rapid onset of action, preferably of a shorter duration is desirable, the quality which Rocuronium is supposed to have.[15] In the present study, we compared Rocuronium with the Succinylcholine in patients requiring rapid sequence induction of anesthesia and endotracheal intubation for emergency surgery. The results of the comparison of Succinylcholine (Group I) and Rocuronium (Group II) for RSI have many findings. Both the groups in our study were comparable with respect to age, sex, weight and the nature of surgery performed, thus demographically similar. There was no statistically significant difference between the two groups. In the present study, the mean onset time of Succinylcholine was 64.50 seconds, which is and the mean onset time of Rocuronium group was 76.50 seconds. But it was significantly prolonged when this study was compared to other researchers.[16-19] We found that Succinylcholine had a slightly faster onset than Rocuronium, by approximately 6 seconds. This difference was statically significant. Results of present study, regarding intubating conditions have been summarized in various tables. Taking together those patients with 'excellent' and 'good' intubating condition, pooled data of our study shows that there is not an appreciable difference in the frequency distribution of clinically acceptable intubating conditions, after the administration of Succinylcholine and Rocuronium. The clinically acceptable conditions are present in 95% and 85% in the two groups receiving Succinylcholine and Rocuronium respectively. Thus our results are in agreement with the findings of other authors[20-23]. In our study we observed that clinically acceptable intubating conditions with Succinylcholine (2 mg/kg) at 60 seconds were found to be 95 % out of 85%excellent belong to Group I. In Group II only (65%) of the patients showed clinically acceptable intubating conditions with Rocuronium 0.6 mg/kg at 60 seconds with excellent conditions seen only in 65% patients. In our study the high incidence of excellent intubating condition might be due to a bit higher dose of Succinylcholine i.e. 2 mg/kg body weight. In the present study, regarding haemodynamic parameter are summarized in observation tables showing preoperative values of pulse rate and blood pressure were taken as control. Among Groups I and II, showed tachycardia in 50% & 60% patients just after intubation. In both the groups however no significant complications like arrhythmias and laryngospasm appeared. In our study, there was laryngospasm in one patient in each group I&II, this complication insignificant. There was a significant change in mean arterial pressure just after administration of drug. We observed an increased heart rate; mean arterial pressure at just after intubation in both groups which persisted up to 5 min in groups. This is same as reported by other authors. The rise in heart rate and mean arterial pressure may be as a result of sympathetic stimulation produced due to laryngoscopy and intubation. In our study, we observed that just after intubation pulse rate and mean blood pressure increase by approximately 19 and 11% in Group I and 18 & 24% in Group II. The comparison of mean pulse rate in between groups was statically insignificant but the mean blood pressure in either group was significant.

CONCLUSION

Succinylcholine is still the drug of choice in emergencies where rapid sequence induction (RSI) of anaesthesia is needed for intubation with rapid onset, rapid recovery and profound relaxation. To avoid the complications of Succinylcholine many new and old non-depolarizing drugs have been tried but Succinylcholine still remains the drug of choice for tracheal intubation in emergencies and full stomach. However, Rocuronium has been claimed to be as good as Succinylcholine at doses ranging from 0.9 to 1.2 mg/kg, the duration of onset of action is much longer. The clinical duration after an intubating dose of 0.6 mg/kg is 30-40 minutes, which is contrary to the need of a short duration muscle relaxant for RSI. Rocuronium in doses of 0.6 mg/kg or more can be useful in patients with pre-existing hyperkalaemia, increased IOP, increased ICP, atypical plasma cholinesterase, bradycardia, anaphylaxis and malignant hyperthermia where use of Succinylcholine may be hazardous.

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