

A COMPARATIVE STUDY OF ROCURONIUM VERSUS SUCCINYLCHOLINE FOR RAPID SEQUENCE INTUBATION (RSI) IN EMERGENCY DEPARTMENT

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Abstract: Rapid Sequence Intubation (RSI) is a life-saving emergency practice of securing the airway of patients needing urgent airway support. Application of an effective neuromuscular blocking agent has a great effect on the success of intubation and the safety of the patient. This paper aimed to find the differences between the efficiency and safety of rocuronium and succinylcholine in RSI in the ED. The type of study was a prospective comparative study (n=100) that included adult patients in need of emergency endotracheal intubation. Participants were selected at random to form two groups, Group R which got rocuronium (1.2mg/kg) and Group S which got succinylcholine (1.5mg/kg). Outcomes such as the time of onset, intubating conditions, first-pass success rate of intubation, duration of paralysis, and adverse events were measured. It was found that succinylcholine had a much more rapid onset of action (46.2 ± 6.9 seconds) than rocuronium (58.4 ± 8.6 seconds). Both the agents had good intubating conditions and the high first pass success but no statistically significant difference between the groups. Rocuronium resulted in a longer duration of paralysis, but with a small number of adverse effects. The instances of hyperkalemia, muscle fasciculations, bradycardia and arrhythmias were also encountered more in the succinylcholine group. The safety profile of rocuronium was the best with the similar level of intravenous efficacy. The researchers conclude that rocuronium and succinylcholine are legitimate agents used in treating RSI in emergencies. Succinylcholine is preferred over rocuronium as it has a quicker onset but rocuronium is safe and a good substitute especially in patients who cannot have succinylcholine due to contraindications.

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I. INTRODUCTION

Rapid Sequence Intubation (RSI) is an urgent practice used in emergency departments in order to provide patients that are unable to maintain adequate oxygenation or ventilation to secure the airway. It is a method that is used in the intubation of the endotrachea in which a sedative agent is quickly administered and then a neuromuscular blocking drug is given, to enable an easier intubation procedure with

reduced chances of aspiration [1]. Airway management in emergency medicine is crucial since failure to manage intubation within a specified timeframe or difficulties associated with the procedure may lead to serious morbidity and fatality. Thus, a proper choice of neuromuscular blocking agent in achieving successful intubation is a key component of patient outcome [2].

Succinylcholine and rocuronium are some of the commonly used neuromuscular blocking agents used in RSI. The gold standard has been considered to be succinylcholine because it acts fast and has a short duration of paralysis. Their features render them especially effective in terms of the emergency situations when swift airway control is necessary [3]. Nevertheless, there are very many negative outcomes related to succinylcholine such as hyperkalemia, malignant hyperthermia, bradycardia, elevated intracranial pressure, and contraindications in some groups of patients. Therefore, investigations have been conducted in an attempt to find other agents due to safety-related concerns. The non-depolarizing neuromuscular blocker, rocuronium has also come out as an alternative to succinylcholine. Rocuronium has a better safety profile at higher doses and provides a rapid onset of action similar to succinylcholine and a better safety profile in many clinical circumstances. However, it can cause difficulties when the intubation cannot be made, or there are complications due to its longer period of paralysis. The hype over the excellence of rocuronium over succinylcholine in treating RSI is still in progress especially in emergency departments where patients are mostly unpredictable and time conscious. The purpose of the study is to compare rocuronium and succinylcholine in regards to conditions of intubation, time changed, first-pass success, time action duration and the adverse events during rapid sequence intubation in the emergency department. The results can be used in evidence-based practice and enhance the airways management in the emergency room.

II. RELATED WORKS

Rapid Sequence Intubation (RSI) is an urgent practice in emergency-medicine, which involves the application of efficient neuromuscular blocking agents, to achieve rapid airflow treatment with limited subdued complications. A number of recent studies have studied different factors of emergency airway management such as intubation method efficacy and safety, use of pharmacological agents, and outcome of the procedure. Kelsey et al. [15] have provided the case report containing details of severe paralysis in myasthenia gravis patients having received rocuronium. They have indicated the need to closely evaluate patients prior to the use of neuromuscular blocking agents especially those with some underlying neuromuscular conditions. The researchers proved that rocuronium can have a long-term effect on paralysis in individuals at risk, and using this treatment in special groups should be used carefully.

Kim et al. [16] contrasted endotracheal intubation with the C-MAC video laryngoscope and direct laryngoscope in case of wearing personal protective equipment by the healthcare providers. The authors

stated that video laryngoscopy enhanced the quality of visualization and intubation performance, which indicates that the quality of airway management is not intimate to the pharmacological supplement, but also to the intubation device used.

One of the most dreaded complications of the use of succinylcholine is malignant hyperthermia. Klinecova et al. [17] analyzed diagnostic and treatment of malignant hyperthermia in critically ill children, and the authors highlighted the need to diagnose and treat the disease early. Their results support the issue of the safety profile of succinylcholine in some categories of patients. Learning to intubate has also received widespread studies. Lee et al. [18] assessed the endotracheal intubation learning curve in the EDs and determined that accumulating clinical practice has a significant positive effect on the first-pass success rate and minimization of the development of procedural complications. Their results show that an operator experience can significantly contribute to the outcome of RSI.

A thorough worldwide review of literature by Martinez-Hurtado et al. [19] investigated contemporary rapid sequence induction and intubation. The authors touched upon the pros and cons of the widely-adopted neuromuscular blocking agents, such as rocuronium and succinylcholine, and came to the conclusion that both the agents are worthwhile alternatives based on patient factors and clinical conditions. Although it is not based on the idea of neuromuscular blockers but on the induction agents, Mendez et al. [20] compared etomidate and ketamine in intubation in the emergency cases of pediatrics. Their study showed that patient outcomes can be greatly affected by the choice of drugs in RSI and the relevance of evidence-based medicine choice at every stage of the intubation process.

Airway registries have found use as more and more useful to assess outcomes in emergency intubation. According to Meulendycks et al. [21], the scoping review of airway registries in adults revealed that standardized data collection has an enhanced ability to offer insight into factors that influence intubation success and safety of patients. The advent of sugammadex has brought about renewed interest in rocuronium, as a substitute to succinylcholine. Motamed [22] touched upon the benefit of sugammadex usage during the emergency and mentioned opportunity to block the effect of rocuronium-induced neuromuscular blockage within few seconds which is one of the significant drawbacks of rocuronium with its long-lasting effect. Mukadder et al. [23] compared the management of anesthesia in the endoscopic myotomy of the peroral and emphasized the significance of using the right neuromuscular blocking agents to provide the safety

of patients and effectiveness of the procedure. Their results also favour personalized choice of drug in the management of airways.

Also, technical reasons for intubation success have been researched. Park et al. [24] studied the influence of the size of the blade on the rates of first-pass successfully removed using a video laryngoscope and found out that a definitive choice of equipment contributes substantially to better results of airway management. On the same note, Patel et al. [25] summarized the use of different strategies to manage elevated intracranial pressure in an emergency and airway stabilization techniques that can be employed to reduce secondary neurological damage during intubation. Lastly, Pazderka et al. [26] tested the quality of an intubation preparation checklist as a graduate medical educator. Their results revealed that protocols of structured preparation can enhance the performance of the procedure and decrease the risks of complication in case of emergency intubation.

III. METHODS AND MATERIALS

Study Design

This was a prospective, comparative, and randomized clinical trial in the Emergency department of a tertiary care teaching hospital. The main dilemma was to compare the effectiveness and safety between rocuronium and succinylcholine when applied in Rapid Sequence Intubation (RSI) in adult patients who situationally need to be assisted to airways [4]. Conditions assessed during the study included intubating conditions, the time of the onset of the neuromuscular blockage, the face of the first-pass intubation success, the action of the element, as well as adverse effects of the two drugs.

Study Setting and Duration

This procedure was carried out at the Emergency Department where patients are critically ill and would often be in need of airway stabilizing. The period of data collection was six months. Only emergency doctors, or anesthesiologists trained in airway management processes, did all the intubations, and were trained in RSI events [5].

Study Population

The population in the study was defined as the adult patients who reported to the emergency department and who had to receive emergency endotracheal intubation with the help of RSI. Suitable screening of eligible patients was done based on specific inclusion and exclusion criteria [6].

Inclusion Criteria

- Adults of age 18 years and older.
- Patients that were in need of emergency endotracheal intubation on RSI.
- There are respiratory failure, trauma, and altered mental condition patients, or any other signs of airway protection.

- The patients whose both rocuronium and succinylcholine were clinically appropriate.

Exclusion Criteria

- Recurrent allergy / hypersensitivity to rocuronium or succinylcholine.
- Past history of malignant hyperthermia.
- Hyperkalemia/diseases that predispose to high levels of potassium in the serum.
- Muscle related neurological conditions, e.g., muscular dystrophy.
- Pregnancy.
- Cases having incomplete clinical records.
- Patients with a sculpting airway in urgent need of surgical intervention.

Sample Size

One hundred patients were used in the study. The patients were randomly divided into two equally consisting groups of 50 patients.

- Group R: Received rocuronium.
- Group S: Received succinylcholine.

To maintain equal distribution and reduce the potential of selection bias, randomization was carried out with the help of a computer-generated random sequence.

Table 1: Study Groups and Drug Administration

Group	Drug Used	Dose Administered	Number of Patients
Group R	Rocuronium	1.2 mg/kg IV	50
Group S	Succinylcholine	1.5 mg/kg IV	50
Total	-	-	100

Materials Used

The research materials used in the study were common airway management equipment and monitoring devices that are found in the emergency departments.

Airway Equipment

- Laryngoscope with Macintosh blades.
- Endotracheal tubes of appropriate sizes.
- Stylets and bougies.
- Bag-valve-mask device.
- Suction apparatus.
- Oxygen delivery systems.

Monitoring Equipment

- Pulse oximeter.
- Electrocardiogram monitor.
- Non-invasive blood pressure monitor.
- Capnography for confirmation of endotracheal tube placement.

Medications

The standard induction agents were offered to the patients in line with departmental procedures. After the induction, rocuronium or succinylcholine had to be administered, on random selection. Rocuronium and succinylcholine (1.2 mg/kg and 1.5 mg/kg, respectively) were administered in higher doses (intravenously).

Study Procedure

Successful patients were recruited into the study after seeking the consent of the Institutional Ethics Committee. Background data such as age, gender, body weight, the reason why intubation was needed and the medical history of the patient were taken.

However before intubation, preoxygenation was administered using 100% oxygen in three to five minutes whenever possible to the patients. Monitoring equipment of standard was fixed in order to constantly measure vital parameters.

An induction agent was given as per routine practice emergency department [7]. The designated neuromuscular blocking agent was then delivered into the body of the patient immediately afterwards. A stopwatch was used to measure the time taken between the administration of drugs and ideal conditions during intubation.

Intubation via the endotrachea was also initiated after the adequate muscle relaxation. Standard intubation scoring criteria was used to determine the ease of intubation. Capnography, expansion of the chest, and bilateral lung sounds confirmation were used to determine a successful placement of the endotracheal tube [8]. During the procedure, and the immediate post-intubation, patients were observed to identify any adverse events.

Outcome Measures

Primary Outcomes

The main results were:

1. Time to neuromuscular block.
2. Quality of conditions of intubation.
3. Success of first-pass intubation.

Time of onset was determined as the time between the administration of the neuromuscular blocking agent and the optimal conditions reached allowing intubation.

A grading of the state of intubation was conducted as excellent, good or poor, depending on the jaw relaxation, levels of the vocal cord and patient response to intubation.

Secondary Outcomes

Secondary outcomes included:

- Duration of neuromuscular blockade.
- Hemodynamic changes.
- Oxygen desaturation episodes.
- Adverse drug reactions.
- Post-intubation complications.

Table 2: Variables Assessed During the Study

Variable	Measurement Method	Type of Outcome
Onset time	Seconds from drug administration to intubation readiness	Primary
Intubating conditions	Excellent, Good, Poor	Primary
First-pass success	Successful first attempt intubation	Primary
Duration of paralysis	Minutes until recovery	Secondary
Heart rate	Continuous monitoring	Secondary
Blood pressure	Non-invasive monitoring	Secondary
Oxygen saturation	Pulse oximetry	Secondary
Adverse effects	Clinical observation	Secondary

Data Collection

A structured case record form, which was specifically designed to carry out the research, was used to gather the data. Immediately after the procedure, demographic factors, clinical observations, details of drug administration, intubation results, and complications were noted. To ensure accuracy of the data, the principal investigator validated all the entries.

Statistical Analysis

The data were collected in the Microsoft Excel and analyzed by the use of Statistical Package of Social Sciences (SPSS) version 26.0. Mean ± standard deviation was used to express continuous variables like age, onset time and duration of paralysis [9]. The frequencies of variables (including intubating conditions and adverse events) were introduced as percentages and frequencies.

Continuous variables of the two groups were compared using independent t-test and the Chi-square test was applied in case of categorical variables. Less than the p-value of 0.05 was taken as statistically significant.

Ethical Considerations

The research carried out was in respect of the ethical guidelines as set in the Declaration of Helsinki. We got permission to conduct the study with the Institutional Ethics Committee. During the research, patient confidentiality and privacy were ensured. Data were reconciled and utilized only in an academic and research manner. Informed consent was sought out in cases where needed and patients or their legal representatives signed informed consent forms prior to taking part in the study.

IV. RESULTS AND ANALYSIS

One hundred patients who needed Rapid Sequence Intubation (RSI) in the emergency unit were enrolled in the research. The two groups of 50 patients each were selected at random. Rocuronium (1.2 mg/kg) was given to Group R and succinylcholine (1.5 mg/kg) gave to Group S. The variables studied were demographic variables, the time when neuromuscular blockade onset, the status of intubation, the success of the first attempt of intubation, time spent paralyzed, and adverse events [10]. Statistical analyses were made to establish whether there were any significant differences between the two sample groups.

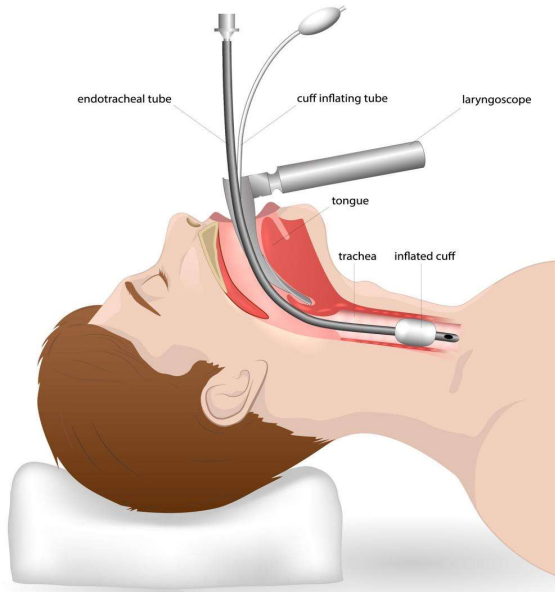


Figure 1: “Standard Rapid Sequence Intubation (RSI) Process in Emergency Airway Management”

4.1 Demographic Characteristics

Table 4.1 gives the baseline demographic features of the patients. The mean age of patients in Group R was 46.8 ± 15.4 years, while in Group S it was 45.2 ± 14.9 years. In both groups, the majority were members of the male individuals. The mean BMI was similar between the trend groups as well. Statistical analysis

showed that no significant difference in the demographic variables between the two groups existed, which means that the two groups were well matched prior to the intervention [11].

Table 4.1 Demographic Characteristics of Study Participants

Variable	Group R (Rocuronium) n=50	Group S (Succinylcholine) n=50	p-value
Mean Age (Years)	46.8 ± 15.4	45.2 ± 14.9	0.62
Male (%)	32 (64%)	30 (60%)	0.68
Female (%)	18 (36%)	20 (40%)	0.68
Mean Weight (kg)	69.4 ± 10.8	68.7 ± 11.2	0.74
Trauma Cases (%)	24 (48%)	22 (44%)	0.69
Medical Emergencies (%)	26 (52%)	28 (56%)	0.69

Analysis

The participants have been randomized successfully as shown by the demographic comparison. The similarity of age structure, gender distribution and weight of the body help minimize the chances of confounding factors affecting the results. Thus, the existence of any differences in the groups can be reasonably due to the neuromuscular blocking agents but not to patient-related factors [13].

4.2 Comparison of Onset Time

The onset time of neuromuscular blockade is one of the most crucial parameters of RSI because on the one hand; airway control is crucial in an emergency. The average onset of the succinylcholine was determined to be much less than that of rocuronium.

Table 4.2 Comparison of Onset Time

Parameter	Group R (Rocuronium)	Group S (Succinylcholine)	p-value
Mean Onset Time (seconds)	58.4 ± 8.6	46.2 ± 6.9	<0.001

Minimum Time (seconds)	45	35	-
Maximum Time (seconds)	75	60	-

Analysis

The findings relate to the fact that succinylcholine caused neuromuscular blockage much quicker compared to rocuronium. The mean time of 46.2 seconds recorded with succinylcholine proves that it has always been regarded as the RSI gold standard. However, persisting to its slow rate, not much more than one minute, rocuronium provided decent intubation conditions in the majority of cases. Its statistically significant difference ($p < 0.001$) indicates that succinylcholine has a speed advantage when there is a need to have immediate airway control.

Mechanism of Action: Succinylcholine

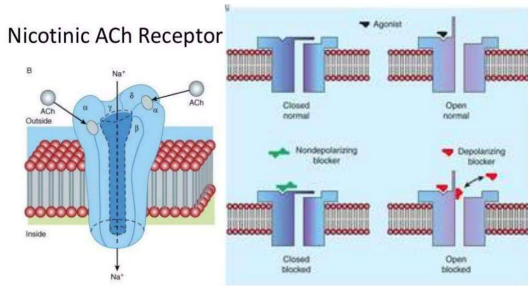


Figure 2: “Comparative Mechanisms of Action of Succinylcholine and Rocuronium at the Neuromuscular Junction”

Nevertheless, the latency that is maintained by high doses of rocuronium is clinically good and can be applied in a case of an emergency [14]. Thus, succinylcholine proved to be faster but rocuronium was also able to satisfy the needs of rapid sequence intubation.

4.3 Intubating Conditions

The quality of the intubating conditions were measured on the grounds of jaw relaxation, position of the vocal cords, and patient response in laryngoscopy. Conditions were rated as excellent, good or poor.

Table 4.3 Comparison of Intubating Conditions

Intubating Condition	Group R (Rocuronium)	Group S (Succinylcholine)
Excellent	40 (80%)	43 (86%)

Good	8 (16%)	6 (12%)
Poor	2 (4%)	1 (2%)
Total	50 (100%)	50 (100%)

Analysis

Both the neuromuscular blocking reagents were favorable in terms of intubating conditions. The rocuronium and succinylcholine succeeded in the establishment of excellent intubation conditions in 80% of patients and 86% respectively. The difference among the groups was not high, and did not become of clinical significance.

The results indicate that with high doses of rocuronium, intubating conditions are similar to those that are achieved with the use of succinylcholine. A low proportion of poor conditions in both groups also indicate that the two agents are effective to promote endotracheal intubation [27]. These results argue in favor of rocuronium as a viable option in case of contraindication of succinylcholine.

Induction Agents				
Drug	Dose (mg/kg)	Duration (minutes)	Onset (seconds)	Notes
Etomidate	0.1-0.6 (0.3)	3-10	30-60	Decreases ICP, adrenal suppression
Propofol	1.5-2.5	5-10	45	Decreases BP, Propofol infusion syndrome
Ketamine	0.5-2 (1)	5-15	30	No effect on respiratory drive, Hallucinations, Increased HR

Paralytic Agents				
Drug	Dose (mg/kg)	Duration (minutes)	Onset (seconds)	Notes
Rocuronium	0.6-1.2	30-60	60	Longer duration of action, less concern for hyperkalemia
Succinylcholine	1-1.5	9-10	60	Reports of fatal hyperkalemia, bradycardia

Figure 3: “Comparison of Onset Time and Duration of Neuromuscular Blockade Between Rocuronium and Succinylcholine”

4.4 First-Pass Intubation Success Rate

The first-pass success is a quality indicator in the management of emergency airways as with repeated attempts to intubate the airways, there is a risk of developing complications, including hypoxia and airway injury.

Table 4.4 First-Pass Intubation Success

Outcome	Group R (Rocuronium)	Group S (Succinylcholine)	p-value

Successful First Attempt	47 (94%)	48 (96%)	0.64
Required Additional Attempt	3 (6%)	2 (4%)	0.64
Total	50	50	-

Analysis

In both groups, the first-pass success rate of intubation was high. The success rate of rocuronium was 94% and that of succinylcholine was a notch higher at 96% success rate. The statistical analysis showed that there was no significant difference between the two groups. These findings mean that both agents are applicable in the management of the airways in the initial attempt. The corresponding small difference is not likely to have a huge clinical significance. As a result, clinicians will be free to select either of the medications depending on patient characteristics and contraindications and with little impact on the success of intubation [28].

4.5 Duration of Paralysis and Adverse Effects

Safety profiles were measured by virtue of the duration of the neuromuscular blockade and adverse effects.

Table 4.5 Duration of Paralysis and Adverse Events

Variable	Group R (Rocuronium)	Group S (Succinylcholine)	p-value
Duration of Paralysis (minutes)	48.6 ± 6.8	9.4 ± 2.1	<0.001
Bradycardia	1 (2%)	5 (10%)	0.09
Hyperkalemia	0 (0%)	3 (6%)	0.04
Muscle Fasciculations	0 (0%)	14 (28%)	<0.001
Oxygen Desaturation	2 (4%)	3 (6%)	0.65
Cardiac Arrhythmias	1 (2%)	4 (8%)	0.17

Analysis

The time the patients took to recover back on their feet was considerably different. Rocuronium was shown to cause a longer neuromuscular blockade of about 49 minutes at the expense of the succinylcholine with a block of duration of only 9 minutes. Although the shorter action of succinylcholine might be beneficial in case of airway management failure, the longer action of rocuronium offers a period of muscle relaxation in persistence of mechanical ventilation. In terms of side effects, succinylcholine had a greater incidence of complications [29]. In 28% of patients who were treated with succinylcholine, muscle fasciculations were seen but not in the group who were treated with rocuronium. The incidence of hyperkalemia was only found in the succinylcholine group and was statistically significant. More common within patients that received succinylcholine were also bradycardia and arrhythmias.

	Succinylcholine	Rocuronium
Dosing	1.5 mg/kg TBW	1 – 1.2 mg/kg IBW
Intubating conditions	Excellent	
Onset	45 seconds	60 seconds
Duration of action	6 – 10 minutes	45 – 60 minutes
Adverse effects	Few serious	None
First pass success	No difference	
Intubation complications	No difference	
Post-intubation sedation	No delay	Maybe delayed
Current practice	Becoming less popular	Becoming more popular

Figure 4: “Clinical Advantages, Limitations, and Adverse Effects of Rocuronium and Succinylcholine in RSI”

There was low incidence of oxygen desaturation across groups and no significant differences across groups. In general, it is possible to consider that rocuronium had a better safety profile, especially in regard to cardiovascular and electrolyte imbalances.

4.6 Overall Comparative Evaluation

The findings indicate that rocuronium and succinylcholine are suitable neuromuscular blocking agents during the rapid sequence intubation in the emergencies. Succinylcholine retained its edge with respect to speed of onset and less duration of action. These features are especially applicable in cases where there is a need to have instant access to the airways and instant recovery of paralysis is required [30].

Nevertheless, rocuronium had almost the same intubating conditions and first-pass success rates. In addition, it also showed the much lower rate of adverse effects. The fact that the rocuronium group did not have fasciculations and hyperkalemia lends support to the safety benefits of using rocuronium in patients who are susceptible to complications of succinylcholine.

The results show that succinylcholine is very useful in treating RSI, but rocuronium can be regarded as an

important alternative, and it is particularly useful in patients who have contraindications to depolarizing neuromuscular blockers. The similar effectiveness and a better safety profile of this study bolster an increase in the utilization of rocuronium in the contemporary management of the airways during emergencies.

4.7 Summary of Findings

The experiment proved that succinylcholine had much quicker neuromuscular blockade onset, rather than rocuronium. However, the two medications exhibited good intubating conditions and great first-pass success. Rocuronium also had a longer period of paralysis with lesser adverse effects, such as no incidences of hyperkalemia and muscle fasciculations. Whereas succinylcholine is still beneficial with regard to the rapid emergence, rocuronium was known to be a safe and useful substitute to RSI in the emergency department. These results imply assessment of the selection of an agent to be specific to patients based on the condition, contraindications, and clinical priorities in the management of the airway.

V. CONCLUSION

Rapid Sequence Intubation (RSI) is an emergency medicine, lifesaving procedure, and the type of neuromuscular blocking agent is the factor that greatly affects the success and safety of the procedure. This paper compared rocuronium and succinylcholine in terms of time to onset, intubating conditions, first-pass intubation success, durability of REBT and adverse effects in patients who underwent emergency endotracheal intubation. The results showed that succinylcholine had a much quicker mechanism of action and would be highly useful in circumstances where the airway needs to be put under instantaneous control. It also resulted in superior intubating conditions, and high first-pass success rate. But succinylcholine was linked to greater frequency of undesirable effects to include muscle fasciculations, hyperkalemia, bradycardia and cardiac arrhythmias. These complications can preclude the use of in patients with distinct contraindications or underlying illnesses.

Though a slower-acting agent, rocuronium gave intubating conditions and a first-pass success that were the same as succinylcholine. Moreover, it had a better safety profile, fewer adverse events and even no hyperkalemia or fasciculations observed in the course of the research. The increased time of paralysis with rocuronium could be beneficial in patients who need more time on the ventilator but could be a drawback when quick restoration of the neuromuscular activity is necessary. In summary, rocuronium and succinylcholine are useful agents of rapid sequence intubation in the ED. Although succinylcholine is the option of choice in instances when onset speed is necessary, rocuronium is a safe and effective option,

especially in patients who are prone to succinylcholine related complications. Selection of these agents should thus be customized on patient factors, clinical status and priorities on airway management.

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