

Comparative Study of Rocuronium Bromide and Succinylcholine Regarding Ease of Intubating Conditions and Hemodynamic Parameters for Rapid Sequence Intubation in Adults

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Abstract

Background: Rapid Sequence Intubation (RSI) is an airway management procedure designed to quickly secure the airway while reducing the likelihood of gastric aspiration during anesthesia induction. For many years, Succinylcholine has been regarded as the preferred neuromuscular blocking agent for RSI because it produces muscle relaxation rapidly and has a relatively brief duration of action. However, its adverse effect profile – including hyperkalemia, bradyarrhythmias, malignant hyperthermia, and increased intracranial and intraocular pressures – limits its use in certain patient populations. Rocuronium bromide, a non-depolarizing neuromuscular blocker, has emerged as a potential alternative capable of producing comparable intubating conditions at higher doses. **Aim:** This study aimed to evaluate and compare the efficacy of Rocuronium bromide (1.2 mg/kg) and Succinylcholine (1.2 mg/kg) with respect to intubating conditions, onset time, and hemodynamic responses during rapid sequence intubation in adult patients. **Methods:** A prospective, randomized clinical study was performed involving 80 adult patients classified as ASA physical status I and II who were scheduled for elective surgery under general anesthesia. Participants were randomly assigned to two equal groups. Group S received succinylcholine (1.2 mg/kg), whereas Group R was administered rocuronium bromide (1.2 mg/kg). Intubating conditions were evaluated using a standardized scoring system that assessed jaw relaxation, ease of laryngoscopy, vocal cord position, and patient response to intubation, including coughing. Hemodynamic variables – such as heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation – were measured before induction and at predetermined time points following intubation. **Results:** Both neuromuscular blocking agents produced acceptable to excellent intubating conditions. No statistically significant differences were observed between the two groups regarding the quality of intubation. Succinylcholine showed a marginally faster onset, while rocuronium demonstrated slightly more stable hemodynamic responses.

All differences were statistically insignificant ($p > 0.05$). **Conclusion:** Rocuronium bromide at 1.2 mg/kg offers intubating conditions comparable to succinylcholine and may serve as a safe and effective alternative, particularly when succinylcholine is contraindicated.

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INTRODUCTION

Endotracheal intubation is widely regarded as the standard technique for establishing and maintaining a secure airway during general anesthesia as well as

in emergency airway management. Rapid Sequence Intubation (RSI) is an airway management approach that facilitates prompt endotracheal tube placement by minimizing the interval between anesthetic induction and intubation, thereby reducing the likelihood of pulmonary aspiration. This technique is commonly recommended for patients who are at increased risk of aspiration, including those with a full stomach, traumatic injuries, gastrointestinal obstruction, pregnancy, or conditions associated with delayed gastric emptying [1].

The classical RSI protocol involves preoxygenation, administration of an induction agent, followed immediately by a neuromuscular blocking drug, and avoidance of mask ventilation prior to intubation. The effectiveness and safety of RSI largely depend on the choice of neuromuscular blocking agent [2].

Succinylcholine, a depolarizing neuromuscular blocking agent, has long been the preferred medication for rapid sequence intubation because of its rapid onset of action, typically within 30–60 seconds, and its brief duration of approximately 5–10 minutes. It exerts its effect by acting as an acetylcholine analogue at nicotinic receptors located at the neuromuscular junction, resulting in sustained depolarization of the motor end plate and temporary muscle paralysis. Although its pharmacological profile is well suited for RSI, its use may be limited by several clinically important adverse effects, including hyperkalemia, bradycardia, Malignant hyperthermia, elevated intracranial and intraocular pressures, and postoperative muscle pain (myalgia). In patients with burns, neuromuscular disorders, spinal cord injury, or electrolyte imbalance, succinylcholine can lead to life-threatening complications [3].

Rocuronium bromide, an aminosteroidal non-depolarizing neuromuscular blocking agent, was introduced as a safer alternative. It exerts its effect by competitively blocking acetylcholine from binding to nicotinic receptors at the neuromuscular junction, resulting in muscle relaxation without causing depolarization. Although its onset is slightly slower at conventional doses (0.6 mg/kg), higher doses (1–1.2 mg/kg) produce intubating conditions comparable to succinylcholine within 60 seconds. The availability of sugammadex, a selective reversal agent, has further enhanced the clinical acceptance of rocuronium by allowing rapid reversal of profound neuromuscular blockade [4].

Hemodynamic stability during intubation is another critical consideration. Laryngoscopy and tracheal intubation stimulate the sympathetic nervous system, leading to transient tachycardia and hypertension. These changes may be harmful in patients with cardiovascular or neurological disease. Therefore, comparing the hemodynamic responses associated with different neuromuscular blocking agents is clinically important.

The present study was designed to assess and compare the clinical performance of Rocuronium bromide and Succinylcholine regarding intubating conditions, onset of neuromuscular blockade, and hemodynamic responses during rapid sequence intubation in adult patients undergoing elective surgical procedures under general anesthesia.

REVIEW OF LITERATURE

The choice of neuromuscular blocking agent for rapid sequence intubation has been the subject of extensive research and clinical debate. Succinylcholine has historically been regarded as the gold standard due to its rapid onset and short duration of action. Its ability to provide excellent intubating conditions within 30–60 seconds made it ideal for emergency airway management.

However, concerns regarding its adverse effects led to increasing interest in non-depolarizing alternatives. Hyperkalemia remains one of the most significant complications of succinylcholine, particularly in patients with burns, crush injuries, spinal cord injuries, prolonged immobilization, and neuromuscular disorders. Fatal arrhythmias associated with potassium release have been reported. Additionally, succinylcholine is a known trigger of malignant hyperthermia in susceptible individuals.

Other undesirable effects include bradycardia, fasciculations, increased intracranial pressure, increased intraocular pressure, and postoperative myalgia [2, 5].

Rocuronium bromide was developed as a non-depolarizing agent with rapid onset characteristics. At standard doses (0.6 mg/kg), its onset time is approximately 90 seconds. However, studies have demonstrated that increasing the dose to 0.9–1.2 mg/kg significantly shortens onset time, producing intubating conditions comparable to succinylcholine at 60 seconds.

Several randomized controlled trials have compared succinylcholine and rocuronium for RSI. Most of these studies reported similar rates of excellent or good intubating conditions when rocuronium was administered in higher doses. Although succinylcholine consistently demonstrated a slightly faster onset of action, the difference was often clinically insignificant when rocuronium was used at 1.2 mg/kg [6].

Meta-analyses have concluded that while succinylcholine provides the fastest onset, rocuronium achieves comparable intubating conditions in most patients. The main disadvantage of rocuronium is its longer duration of action, which may be problematic in cases of failed intubation. However, the introduction of sugammadex has mitigated this concern. Sugammadex encapsulates rocuronium molecules, rapidly reversing neuromuscular blockade within minutes, even from deep levels of paralysis.

Hemodynamic effects of both agents have also been studied extensively. Laryngoscopy itself is responsible for most sympathetic stimulation, rather than the neuromuscular blocker. Nevertheless, some studies suggest that succinylcholine may be associated with mild bradycardia or transient hypertension, whereas rocuronium tends to produce stable cardiovascular responses. Overall, most studies report no significant difference in heart rate or blood pressure changes between the two agents when appropriate anesthetic depth is maintained [7].

In obese patients and those with comorbid conditions, rocuronium has shown comparable oxygen saturation and intubation success rates. Furthermore, rocuronium does not cause fasciculations, making it more comfortable for patients and reducing postoperative muscle pain.

Despite extensive research, clinical preference often depends on institutional protocols, availability of reversal agents, and patient-specific contraindications. With increasing awareness of succinylcholine-associated complications and the availability of rapid reversal for rocuronium, the latter has gained popularity as a first-line agent for RSI in many centers [8, 9].

Overall, existing literature supports the hypothesis that rocuronium at higher doses can serve as an effective and safe alternative to succinylcholine for rapid sequence intubation.

MATERIALS AND METHODS

Study Design

Sample Size and Population

This prospective, randomized, comparative study was carried out in the Department of Anaesthesiology at a tertiary care hospital. Approval was obtained from the Institutional Ethics Committee before the initiation of the study, and written informed consent was secured from all participants prior to their enrolment. A total of 80 adult patients undergoing elective surgical procedures under general anesthesia that required endotracheal intubation were enrolled in the study.

Inclusion Criteria

- Age between 18 and 60 years.
- ASA physical status I or II.
- Mallampati Grade I or II.
- Elective surgical procedures of duration 30 minutes to 3 hours.

Exclusion Criteria

- BMI > 30 kg/m².
- Anticipated difficult airway.
- Pregnancy.
- Cervical spine pathology.
- History of hyperkalemia.
- Neuromuscular disorders.
- Cardiovascular, renal, hepatic, or metabolic disease.
- Risk of aspiration.

Group Allocation

Patients were randomly allocated into two groups of 40 each:

- *Group S*: Received succinylcholine 1.2 mg/kg IV.
- *Group R*: Received rocuronium bromide 1.2 mg/kg IV.

Randomization was performed using a computer-generated sequence.

Preoperative Preparation

All participants underwent a comprehensive pre-anesthetic assessment on the day preceding surgery. Routine preoperative investigations were completed according to institutional protocol. Patients were instructed to remain nil per oral (NPO) for 8–12 hours before the procedure. As premedication, oral Alprazolam 0.25 mg and Pantoprazole 40 mg were administered on the night before surgery and repeated on the morning of the operation.

Intraoperative Procedure***Baseline Parameters Were Recorded***

On arrival in the operating room, standard anesthetic monitoring was established, including continuous electrocardiography (ECG), non-invasive blood pressure (NIBP) monitoring, and pulse oximetry (SpO₂). Intravenous access was obtained using an 18G or 20G peripheral venous cannula before the induction of anesthesia.

- Heart rate.
- Systolic blood pressure.
- Diastolic blood pressure.
- Mean arterial pressure.
- Oxygen saturation.

All patients were preoxygenated with 100% oxygen for 3 minutes.

Premedication Included

- Fentanyl 2 µg/kg.
- Midazolam 1 mg.
- Ondansetron 4 mg.
- Lidocaine 2%.

Induction was achieved using propofol 2 mg/kg or thiopentone sodium 100 mg IV.

Following loss of consciousness, the assigned neuromuscular blocking agent was administered. Cricoid pressure was applied immediately after induction.

Laryngoscopy and endotracheal intubation were performed 60 seconds after administration of the neuromuscular blocker using an appropriately sized cuffed endotracheal tube.

Assessment of Intubating Conditions

Intubating conditions were evaluated using a standardized scoring system assessing:

- Jaw relaxation.
- Ease of laryngoscopy.
- Vocal cord position.
- Coughing response.

Each parameter was graded as excellent, good, fair, or poor.

Hemodynamic Monitoring

Hemodynamic parameters were recorded at:

- Baseline.
- Pre-intubation.
- 1-minute post-intubation.
- 2 minutes post-intubation.
- 5 minutes post-intubation.

Maintenance and Reversal

Anesthesia was maintained using nitrous oxide (66%), oxygen (33%), isoflurane (1–2%), and intermittent doses of rocuronium.

At the end of surgery, neuromuscular blockade was reversed using neostigmine (0.08 mg/kg) and glycopyrrolate (0.2 mg per 1 mg neostigmine). Patients were extubated after adequate recovery.

Statistical Analysis

The collected data were entered into Microsoft Excel and subsequently analyzed using IBM SPSS Statistics. Continuous variables were summarized as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the student's t-test for continuous data and the Chi-square test for categorical data, as appropriate. A *p*-value of less than 0.05 was considered indicative of statistical significance.

DISCUSSION

Rapid Sequence Intubation (RSI) is an essential airway management technique in anesthetic practice, especially for patients with an increased risk of pulmonary aspiration. An ideal neuromuscular blocking agent for RSI should produce a rapid onset of muscle paralysis, facilitate optimal intubating conditions, maintain hemodynamic stability, and have a favorable safety profile with minimal adverse effects. For decades, succinylcholine has fulfilled most of these criteria and has, therefore, been widely accepted as the gold standard. However, its adverse effect profile has led clinicians to seek safer alternatives. Rocuronium bromide, particularly in higher doses, has emerged as a promising substitute [10].

In the present study, administration of Succinylcholine (1.2 mg/kg) and Rocuronium bromide (1.2 mg/kg) resulted in satisfactory intubating conditions when assessed 60 seconds after drug administration. The percentage of patients exhibiting excellent or good intubating conditions was similar in both groups. Although succinylcholine showed a slightly more rapid onset of neuromuscular blockade than rocuronium bromide, the observed difference was not statistically significant and had no appreciable impact on the overall success of endotracheal intubation [11, 12].

These findings align with multiple previously published randomized trials comparing high-dose rocuronium with succinylcholine. Most studies have shown that when rocuronium is administered at 1–1.2 mg/kg, intubating conditions at 60 seconds are like those achieved with succinylcholine. While succinylcholine consistently demonstrates the fastest onset time, the difference is often less than 15–20 seconds and may not be clinically significant in controlled operating room settings [13].

One of the major advantages of rocuronium observed in this study was hemodynamic stability. Laryngoscopy and intubation are known to cause sympathetic stimulation resulting in transient tachycardia and hypertension. In our study, both groups exhibited a mild increase in heart rate and blood pressure immediately after intubation; however, the magnitude of change was slightly lower in the rocuronium group. Although these differences were statistically insignificant, the trend suggests that rocuronium may offer more stable cardiovascular responses.

Succinylcholine is associated with several well-documented adverse effects including hyperkalemia, bradyarrhythmias, increased intracranial pressure, increased intraocular pressure, postoperative myalgia, and the risk of malignant hyperthermia. These complications, although infrequent, can be life-threatening in susceptible individuals. Rocuronium does not produce fasciculations and does not trigger malignant hyperthermia, making it a safer option in high-risk populations [14].

The longer duration of action of rocuronium has traditionally been considered a disadvantage, especially in cases of failed intubation or difficult airway scenarios. However, the introduction of sugammadex has significantly changed this perspective. Sugammadex allows rapid and complete reversal of even profound rocuronium-induced neuromuscular blockade within minutes. This development has greatly enhanced the safety profile of rocuronium and has contributed to its increasing use in rapid sequence induction protocols worldwide.

In the context of developing countries or resource-limited settings where sugammadex may not be readily available, clinicians must carefully weigh the risks and benefits of using high-dose rocuronium. Nonetheless, in patients where succinylcholine is contraindicated – such as those with neuromuscular disorders, burn injuries, spinal cord trauma, hyperkalemia, or susceptibility to malignant hyperthermia – rocuronium remains the preferred alternative.

Therefore, the findings may not be generalizable to emergency cases, critically ill patients, or those with significant comorbidities. Additionally, neuromuscular monitoring using train-of-four stimulation was not employed, which could have provided more objective assessment of onset and recovery times.

Despite these limitations, the study provides valuable evidence supporting the use of rocuronium bromide as a safe and effective alternative to succinylcholine for rapid sequence intubation. The comparable intubating conditions, acceptable onset time, and favorable hemodynamic profile suggest that rocuronium can be confidently used in routine anesthetic practice [15].

Future studies with larger sample sizes, inclusion of high-risk patients, and incorporation of objective neuromuscular monitoring would further strengthen the evidence base. Comparative cost-effectiveness analyses may also help institutions formulate standardized RSI protocols.

CONCLUSION

The present study demonstrates that rocuronium bromide at a dose of 1.2 mg/kg provides intubating conditions comparable to succinylcholine 1.2 mg/kg at 60 seconds during rapid sequence intubation. Although succinylcholine exhibits a slightly faster onset of action, the difference is not clinically significant. Hemodynamic responses were similar in both groups, with rocuronium showing a trend toward greater cardiovascular stability. Considering the adverse effect profile of succinylcholine and the availability of rapid reversal agents for rocuronium, rocuronium bromide may be considered a safe and effective alternative for rapid sequence intubation, particularly in patients where succinylcholine is contraindicated.

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